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F. S. CIRCULAR 38

INSTRUCTIONS TO ENGINEERS
OF TIMBER TESTS

(Revised)

TIMBER MECHANICS FILES
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GIFFORD PINCHOT, Forester.

INSTRUCTIONS TO ENGINEERS OF TIMBER TESTS.

(REVISED.)

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INSTRUCTIONS TO ENGINEERS OF TIMBER TESTS.

(REVISED.)

INTRODUCTION.

This manual is a revision of Forest Service Circular 38, entitled "Instructions to Engineers of Timber Tests," and presents detailed instructions for testing timber and recording the data obtained, which are standard at the date of publication. These instructions are, as far as possible, to be followed literally in all timber tests made by the Forest Service.

The purposes of the tests carried on by the Forest Service are to determine the relation between the physical characteristics of wood and its mechanical properties; to determine the effect of various technological processes upon the mechanical properties and to establish authoritative data for design; to collect data for the improvement of specifications for market products; to study the best methods of testing; to determine the best uses for woods grown in the National Forests; and to determine what species may be used as substitutes for those now becoming scarce.

In general, three forms of material are tested:

Form 1.—Large timbers, such as bridge stringers, car sills, and other pieces 5 feet or more in length.

Form 2.—Small pieces not included in Form 1, such as are used in compression parallel to grain, compression at right angles to grain, shearing, and in small bending tests.

Form 3.—Manufactured articles, such as packing boxes, wagon axles, spokes, etc.

The following analyses, either in whole or in part, are made upon the results of any series of tests, and are called studies:

Study 1.—To determine average weights and strength values.

Study 2.—To determine the influence of defects.

Study 3.—To determine the influence of rate of growth.

Study 4.—To determine the influence of specific gravity.

Study 5.—To determine the influence of summer wood.

Study 6.—To determine the relative strength of sapwood and heartwood and the influence of position in tree.

Study 7.—To determine the effect of different methods of drying and seasoning.

Study 8.—To determine the effect of different methods of treating with preservatives, fire retardants, etc.

Study 9.—To determine the effect of various methods and rates of loading.

Study 10.—To determine the influence of moisture.

These numbers are used by all laboratories. Thus Study 3 designates at each laboratory an analysis to determine the influence of rate of growth on the various mechanical properties. Each laboratory, however, does not necessarily work upon all studies.

DUTIES OF ENGINEER.

The engineer in charge of a laboratory is responsible for the accuracy of the results obtained at his laboratory. He is not responsible for the methods of test selected, but he should advise the central office of any improvements in any part of the work which may seem advisable to him as a result of his experience. He is also responsible for the progress of the work. He should bear in mind that the expense of carrying on the work is heavy, and it should therefore be pushed as rapidly as is consistent with accuracy. He is not ordinarily charged with the duty of selecting the material to be tested. Assistance in selecting material may be given by other members of the Forest Service. The engineer, by making abstracts of data, should keep track of the general character of the results obtained, so that any mistakes of selection or in methods pursued may be detected before the investigation proceeds too far.

CARE OF APPARATUS.

The engineer in charge is held responsible for the condition of the apparatus in his care. He should keep an inventory of the apparatus in the laboratory, and note breakage, losses, or transfers. There will be provided a proper receptacle for the apparatus in the laboratory, and, after the testing work is over, all apparatus should be carefully put away and protected from rust.

THE TESTING MACHINE.

The gears should be oiled[a] about once a week. It is very necessary that the screws of both the Olsen and Riehlé machines should be

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[a] The following instructions are given by the manufacturers of the Olsen testing machine:

Oil the four pulling screws well, at least once a day when in constant use, directly on the threads or in the featherway of same. Oil central vertical shaft once a week through an oil hole in the horizontal bevel wheel inside of the drum, or base, of the machine. Oil, once a day, the horizontal shaft for wiped clear of grit once a week, and in case they become gummed the gummed oil should be removed with gasoline and the screws re-oiled. Lost motion or unequal wear in the screws should be taken up by the means provided by the manufacturer. Care should be taken in operating the levers of the testing machine not to throw in the gear while in motion. The bearings of the knife-edges should be kept clean and examined at intervals. If the machine has an extension base it is particularly important that clearance exist between the floor of the laboratory and all parts of the base used in weighing. Slush should be used on the wedges and other exposed metal surfaces of the machine to keep them from rusting.

CALIBRATION OF APPARATUS.

Before leaving the factory the testing machines are, as a rule, calibrated to a portion of their capacity. The delicacy of the weighing levers is verified by determining the number of pounds which will cause the beam to move between the stops while a load of 1,000 pounds rests on the platform. The usual requirement is that 10 pounds should accomplish this movement. The machines used in testing timber are calibrated by the use of a standard bar and an extensometer. This standard bar should be of steel, about 1 inch in diameter, with an elastic limit of at least 85,000 pounds per square inch. The machine is calibrated by pulling this bar nearly up to the elastic limit and noting the readings of the extensometer. The deflectometers should be calibrated as often as necessary to determine their accuracy.

TERMS USED IN DESCRIBING AND MARKING MATERIAL.

The engineer is also responsible for the proper adherence to the following terms and definitions in describing and marking material for test:

(*a*) A *shipment* is a lot of material which may be considered as having been handled as a unit before reaching the laboratory. A "shipment" may all be received at one time, as a carload of timbers, or it may be received in two or more installments.

(*b*) A *piece* is the first subdivision of a "shipment" which it is desirable to regard as a unit. It may be a log, a stringer, a strip from which small specimens are to be taken, or a wagon axle. Each "piece" in the shipment will be given a number. If the "pieces"

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large spur wheel by pouring oil in groove from the outside, through the spokes of the spur wheel; oil the countershaft and loose pulleys once or twice a day. Oil the main bearings for the four pulling screws well once a week by pouring oil in the holes on side of top of drum.

are tested, each test specimen will have but two numbers, one designating the " shipment " and one the " piece."

(*c*) The term *stick* is applied to specimens secured from the first subdivision of a " piece." " Sticks " will have three numbers, a " shipment " number, a " piece " number, and a " stick " number.

(*d*) A *mark* consists of one or more characters signifying factors which are to be considered in analyzing the test data. Arabic numerals in a " mark " signify that the test was made on a specimen cut from a " stick;" e. g., very often small compression and shearing test specimens are secured from small bending specimens; accordingly the " mark " of such a specimen will contain an Arabic numeral. Such specimens will also bear the " shipment," " piece," and " stick " numbers of the specimen from which they are cut. Letters, Roman numerals, and other characters may be embodied in the " mark " to designate methods of drying and treating, position in tree, etc., when it is desirable to make a record of such factors.

Whenever possible, the common species names adopted in Forest Service Bulletin 17, " Check List of the Forest Trees of the United States," will be used in preference to the Latin names.

WORKING PLANS.

Before any piece of work is undertaken a working plan must be authorized by the central office. The plan will cover the following points:

(1) Purpose of the investigation.

(2) Material needed.

Species, condition, size, etc.

(3) Marking and testing.

Any special methods of test should be fully described.

(4) Key to characters used in "marks."

This key should fully describe the various factors and processes designated by the different marks.

(5) When possible, proposed methods of analyzing data, diagrams to be prepared, and elements to be covered in formal conclusions.

Each working plan will be given a title, and, when approved, will be numbered and dated by the central office and will be filed numerically. The following information will be added to the working plans as it becomes available:

(*a*) Shipments used.
(*b*) Date of beginning and completion of tests on each shipment.
(*c*) Photographs taken.
(*d*) File numbers and titles of summaries, diagrams, and reports.

SAMPLE WORKING PLAN.

OFFICE OF WOOD UTILIZATION.

TIMBER TESTS.

Working Plan No. 7.

To determine the effect of creosoting by the boiling process on the strength of Douglas fir.

Purposes of the investigation:

The purposes of the investigation are—

(1) To determine the effect of the process on—

 (*a*) The general appearance of the stringers.
 (*b*) Their strength.
 (*c*) Their moisture content.

(2) To determine the amount and distribution of oil in the treated specimens.

(3) To determine the effect of seasoning on the strength of treated specimens.

Material needed:

Thirty 8″ by 16″ by 32′ Douglas fir stringers representing the range in market material will be so selected that there will be 10 best quality, 10 good quality, and 10 poor quality stringers. In estimating quality the engineer must rely upon his own judgment, basing it largely upon the work which has been done to determine the influence of defects, per cent of summer-wood, rate of growth, etc. It will be the aim to secure stringers showing a uniform condition throughout their length.

Forest Service tests have shown that the grades select, merchantable, and seconds, as defined by the export grading rules of the Pacific Coast Lumber Manufacturers' Association, represent very well the three qualities mentioned above.

Grouping and marking:

The 30 stringers are to be divided into 15 groups of 2 stringers each:

 Groups 1 to 5, inclusive, will be best quality stringers.
 Groups 6 to 10, inclusive, will be good quality stringers.
 Groups 11 to 15, inclusive, will be poor quality stringers.

The two stringers of each group are to be as nearly alike in their physical qualities as possible. To a great extent the value of the results obtained from this series of tests depends upon the skill and care exercised in grouping the stringers. If practicable the weight of the stringers should be considered in grouping.

Each 32-foot stringer will be given two numbers, one for each end, the butt end an odd number, 1, 3, 5, 7, etc., and the top end the next higher even number, 2, 4, 6, 8, etc.

Treatment:

Each 32-foot stringer will be cut in two, thus furnishing two 16-foot beams. One of these beams is to be treated and then tested, and the other is to be tested untreated. At the time of cutting a moisture determination will be made in the manner described under the heading "Moisture determinations."

Each 16-foot beam will be weighed immediately before testing, and, if treated, immediately before and after treatment.

To secure uniformity in each group the two pieces from any one group which are to be treated must invariably be treated together. Under no circumstances shall they be treated in different runs.

The engineer and his assistant shall make complete logs of each run, showing all the pertinent data. The interval of time between the different observations will depend upon the variability of the different factors. The observations should be frequent enough, however, to furnish a complete record of the process. The sizes making up the charge and the general moisture condition of the material, as well as the quantity of oil forced into the charge by the treatment, should be noted.

Summary:

The numbers in this summary are so arranged that all the numbers in the same vertical line represent the beams composing one group. If the pieces are marked in accordance with these instructions, the following will be—

Tested green	2	5	10	13	18	21	26	29	34	37	42	45	50	53	58
Air dried and tested [a]	4	7	12	15	20	23	28	31	36	39	44	47	52	55	60
Treated and tested	1	6	9	14	17	22	25	30	33	38	41	46	49	54	57
Treated, air dried, and tested [a]	3	6	11	16	19	24	27	32	35	40	43	48	51	56	59

Testing:

Main beams: All 16-foot pieces will be tested under third point loading over a 15-foot span according to the standard method. The usual sketches will be made of the four sides, butt and top ends, failure, and method of cutting up the beam after test.

Minor test specimens: The chief purpose of the minor tests will be to determine the relative strength of the surface and interior portions of the beam for various natural and treated conditions. Material for these tests will be secured as follows for each main beam tested:

(*a*) For compression perpendicular to grain, one 8″ by 16″ by 30″ piece.

(*b*) For shearing, one 8″ by 16″ by 6″ piece. From this 6-inch section two radial and two tangential shear blocks will be taken, one of each kind from the surface and interior portions of the beam, respectively.

(*c*) For 2″ by 2″ by 30″ bending, one 8″ by 16″ by 30″ section. This section will be cut up into 18 small pieces. From these 18 pieces 10 without injurious defects will be selected.[b] It is desirable to have at least two pieces from the interior part of the section tested under static loading.

(*d*) For compression parallel to the grain, one 2″ by 2″ by 8″ block will be taken from each Form 2 bending specimen. These blocks will be tested in the usual manner.

Marking:

It is necessary that the standard system of marking be closely followed in preparing log sheets.

In all tests made under this working plan, the term—

"*Shipment*" will apply to the whole consignment of thirty 8″ by 16″ by 32′ stringers;

"*Piece*" will apply to each 8″ by 16″ by 16′ beam;

"*Stick*" will apply to each test specimen secured directly from an 8″ by 16″ by 16′ "piece."

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[a] As soon as possible after arrival at the laboratory the modulus of elasticity of these beams should be determined by applying about a 10,000-pound load and noting the deflection.

[b] Six to be tested under static loading and 4 under impact loading. The latter will be sent to the central laboratory.

It is planned to secure from each "piece" 4 shearing, 10 Form 2 bending, and 1 compression perpendicular to the grain specimen. Thus stick numbers will run from 1 to 15, inclusive.

The Form 2 compression specimens will have the same numbers as the "sticks" from which they are cut, and, in addition, will bear the numeral 1 in their "mark." If it is decided to take other specimens from the "stick," they will be numbered consecutively 2, 3, etc. These numbers will be embodied in the "mark." The letters *a*, *b*, *c*, *d*, and *e* will be used in the mark to indicate the portion of the cross section from which the different small test specimens are secured. Shear specimens and Form 2 compression parallel to the grain specimens will bear one of these "marks." The letters will indicate, respectively, that the specimen was taken from the *a*, *b*, *c*, or *d* side of the beam, or from the central portion.

Moisture determinations:

The following method of making borings is to be employed only on the original 32-foot stringers and on the treated pieces after test. The untreated pieces are to have moisture disks cut from them in the usual manner.

When each 32-foot stringer is cut through in the center, just before treating one of its halves, the freshly cut surface of the piece to be tested untreated will be marked off into the usual nine divisions. Three holes will then be bored into each division with a 1-inch bit to a depth of exactly 2 inches. The borings from each hole will be carefully saved, and the borings from the three holes in each section will be placed together in a bottle, tightly stoppered, and marked with the proper disk and section numbers.

Borings from the treated tested pieces will be made in a similar manner, approximately 5 feet from that end which was at the center of the original stringer, with the exception that the borings will be made upon both sides of the saw cut, thus giving two complete sets of borings. Each set will be handled independently, thus making 18 bottles for each treated tested piece. Besides marking these bottles containing creosoted borings with the necessary piece and stick numbers, the weight of the contents (taken immediately after boring) should be marked on the label.

Since it is practically impossible to extract completely the creosote in the treated borings, it will be necessary in determining the percentage of moisture in them to use the oven-dry weights of the untreated borings taken from the untreated half of the original stringer. The bottles containing the borings from the treated and tested pieces will be sealed with paraffin or sealing wax and shipped to the central laboratory.

Moisture determinations on the borings from the original 32-foot stringers will be made at the Seattle Laboratory.

The untreated borings will be dried to a constant weight at 100° C. in some vessel which will allow complete circulation of air and vapor without allowing any of the wood fibers to escape.

Photographs:

Photographic disks should be cut from each treated beam in the region of failure. These disks will be photographed in groups of 4. The purpose of the photographs will be to show the penetration secured by the treating process. Great care must be used in preparing these disks to avoid any misleading surface staining on the faces. Full-sized sketches should also be made immediately after cutting.

Some typical and abnormal failures will also be photographed. The engineer in charge of the work may use his discretion in taking other photographs.

Diagrams, etc.:

Diagrams and summaries shall be made showing the following:

(1a) Relative strength of green beams and beams tested immediately after treating.

(1b) Relative strength of Form 2 specimens taken from different parts of the treated and tested beams.

(1c) Change in moisture content of beams during treatment.

(2a) Relative strength of treated and untreated seasoned beams.

(2b) Relative strength of Form 2 specimens taken from different parts of treated, air dried, and tested beams.

(2c) Change in moisture content of treated and untreated beams during seasoning.

(3) Comparison of treated and untreated material before and after seasoning.

Other summaries and diagrams which are needed to show the various effects of the process on the physical properties of the wood.

Material used, photographs taken, summaries made, etc.:

Shipments used:

Shipment S 17. Tests started 11 Feb., '08.

Photographs taken:

63998. End sections of pieces 1, 6, 9, and 14.
63999. End sections of pieces 17, 22, 25, and 30.
64000. Showing typical failure of green beams.
64001. Showing typical failure of treated beams.

Summaries made:

183. "Strength of green Douglas fir stringers."
184. "Strength of treated Douglas fir stringers."

Reports submitted:

"Preliminary report on the effect of creosoting by the boiling process on the strength and other properties of Douglas fir." File No. 46.

SAMPLE WORKING PLAN.

OFFICE OF WOOD UTILIZATION.

TIMBER TESTS.

Working Plan No. 8.

Comparison of the mechanical and physical properties of different woods.

Purpose of the investigation:

The purpose of this investigation is to compare the mechanical and physical properties of different species of wood.

Material needed:

The material needed in this investigation will be collected by members of the Service, who will furnish the necessary data on its origin, collection, and shipment. It will be sent to the laboratory in the form of slash-sawed planks 4 inches thick.

Material to be tested green will be shipped in such quantities and at such times that the tests may be made immediately. The storage of green material during the progress of the tests will be under conditions fixed by the central office. Material to be dried will be stored in the shed, so as to permit the free circulation of air.

If the material checks, the ends of the sticks should be paraffined. The planks will be cut up in such a way as to give a set of clear, straight-grained sticks, varying in rate of growth from rapid, through normal, to slow. Each stick should be of fairly uniform growth throughout its cross section, and, whenever possible, all heartwood or all sapwood.

Marking specimens:

The scheme of marking used will be standard. All material of one species secured from a single site will constitute a shipment. When received at the laboratory, each plank will have the tree number as given by the collector, which will be included in the marks of the test specimens.

Tests:

For general studies, material for at least 300 specimens for 2 by 2 inch bending tests should be obtained; material for at least 150 specimens should be collected from each region for use in comparing different regions; material for at least 75 test specimens should be obtained from each site for comparing sites.

Tests are to be distributed as follows:

	Per cent.
Bending:	
Static (green)	65
Static (dry)	10
Impact (green)	7½
Impact (dry)	7½
Torsion (green)	3
Torsion (dry)	4
Shrinkage	3

These percentages are to be made up of heartwood sticks and sapwood sticks in about the same ratio as heart and sap occur in the shipment. Tests will be made in the standard way, except when otherwise noted.

Before testing, the specimens will be dressed to size. Especial precaution will be taken to prevent case-hardening. If it is impossible to test the specimens (to be tested green) immediately after they have been dressed, they will be kept in a moist closet or box until needed.

Tests in compression parallel to the grain, compression perpendicular to the grain, and shear are to be made on pieces cut from the static bending specimens. A moisture determination will be made for each specimen tested.

The engineer in charge is to use his discretion in taking photographs. It is desirable to secure good photographs of typical failures of rapid, normal, and slow-growth material.

Bending: The size of the specimens and method of test will be standard. To secure the total rupture work, the load-deflection readings for 50 per cent of the test specimens are to be continued until failure is so complete that the stick sustains practically no load. (Note: Either 6 inches deflection or 200 pounds is a practical limit.) Roller bearings will be used, and rings will be placed parallel to the direction of the load. The deflection at the maximum load will be recorded in all tests.

Compression parallel to grain: One standard specimen will be taken from each beam. Load-deformation readings will be taken well past the E. L. load for 20 per cent of the tests; for the remainder the maximum load only will be determined.

Compression perpendicular to the grain: One standard specimen will be taken from each beam. One-third of the number will be tested and the remainder stored under water. Load-deflection readings are to be taken until the yield point is well passed.

Shear: This test will be standard, using the smaller size of shear block. Specimens will be taken from one-third of the beams tested under static loading.

Torsion: The rough strips reserved for torsion tests will be sent to the central laboratory, where they will be prepared and tested in the standard manner. The chief purpose of the torsion tests is to show the toughness of the wood, and each test should be continued long enough to completely develop the failure.

Abrasion: The size of the specimens will be standard. Material for 10 dry and 10 green tests will be sent to the central laboratory. The specimens will be cut from the ends of the impact bending test specimens.

Shrinkage: This test will be made in the standard manner.

Impact: The size of the specimens will be standard. The material for impact tests, one-half to be tested green and one-half air-dry, will be sent to the central laboratory. From each impact test specimen a 2″ by 2″ by 8″ specimen will be cut and tested in compression parallel to the grain. In the latter tests the maximum load only will be taken.

Diagrams, etc.:

When the tests on any one species have been completed, summaries will be made showing the average strength values for that species, both green and seasoned. When possible, other summaries showing the comparative strength of the same species for the different sites and localities will be prepared.

Diagrams showing the relation of the mechanical properties to rate of growth and dry specific gravity will also be made.

Material used, photographs taken, summaries made, etc.:

Shipments used:

Shipment S 16. Tests started 26 Jan., '08, finished 6 May, '08.
Shipment S 18. Tests started 16 Feb., '08, finished 9 May, '08.
Shipment P 43. Tests started 23 Jan., '08, finished 3 Mar., '08.
Shipment P 44. Tests started 29 Jan., '08, finished 9 Mar., '08.
Shipment P 45. Tests started 17 Feb., '08, finished 3 Apr., '08.
Shipment P 46. Tests started 13 Mar., '08, finished 5 May, '08.

Photographs taken:

63445. Showing method of making flexure tests.
63446. Showing the excessive flexure of hickory specimens.
63447. Showing torsion test.
63448. Showing the same.
63997. Showing method of testing side compression specimens.

Summaries made:

156. "Comparative strength of various species of hickory."
177. "Bending strength of green incense cedar."

Reports submitted:

Strength of different species of hickory.
Strength of incense cedar.

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SHIPMENT DESCRIPTIONS.

All material received at a laboratory must be given a shipment number and fully described. The description of a shipment will include the following:

(1) The form and condition of the material when received at the laboratory.

(2) How and when material was shipped and date of receipt at the laboratory.

(3) Complete history of material, stating, when possible, place and site conditions where felled, when and at what mill manufactured, how stored after reaching the laboratory, and other information relative to the shipment as a whole.

(4) The number of the working plan covering the tests and field numbers of photographs taken of the material.

Every shipment will be given a number at the laboratory and the shipment description filed numerically. A letter signifying the laboratory at which the shipment is received will be used in conjunction with the shipment number. In selecting material for any series of tests the engineer should be very careful to obtain only such material as will best serve the purpose of the tests, and every effort should be made to secure complete information on its origin and history.

Usually test material will be secured and selected under special instructions from the central office.

SAMPLE SHIPMENT DESCRIPTION.

OFFICE OF WOOD UTILIZATION.

TIMBER TESTS.

SEATTLE LABORATORY.

Shipment S–15, Western Larch.

Material:

23 8″ by 16″ by 16′ beams.
29 8″ by 12″ by 16′ beams.
29 5″ by 8″ by 16′ beams.
9 2″ by 12″ by 16′ joists.

The pieces in each group represented fairly well the general range in market material. They were thoroughly green when received at the laboratory, a trial moisture determination indicating a moisture content of 56.2 per cent.

How and when shipped:

The shipment was made on a flat car from Spokane, Wash., October 9, 1907, via the Northern Pacific. The beams were close piled and covered with 2″ by 12″ by 16′ joists. Arrived at Brooklyn Switch, Seattle, on October 23, 1907.

History:

The trees from which the material was cut were selected by John Doe. They were cut September 12 and 13, 1907, on the holdings of the ——— Lumber

Company in Stevens County, Wash., near the foot of a moderate slope in a small canyon.

The logs were marked in the woods and taken to the mill on flat cars. Two numbers were used in marking, the first number representing the tree number and the second the cut.

The logs were sawed at the mill of the ——— Lumber Company, Spokane, Wash., September 23, 1907. After sawing, the beams were close piled under cover until shipped. Upon arrival at the laboratory the beams that were to be tested green were close piled under cover until tested; the remainder were set aside to air season in an open shed.

Photographs taken: None.

Working plan used: No. 15,

PHOTOGRAPHS.

Engineers in charge should photograph typical and abnormal failures, also special apparatus and methods of test which are not standardized. Photographs of special apparatus will be supplemented by drawings. Other photographs which can be used with advantage in the work will also be taken.

Dry plates will be used exclusively, and will be purchased in the field. All plates purchased will be charged against the laboratory on the books of the Forest Service, and will remain so charged until the plates are sent in to the Service photographer, Washington, D. C.

All plates exposed at testing laboratories will be developed at the laboratories, and one print, properly marked, sent to the central office. After prints sufficient for the needs of the laboratory have been made the plates will be carefully stored to prevent breakage or damage. Testing laboratories without dark-room facilities will, if it is found necessary, be provided with such rooms. A photographer, however, may be employed to do the developing.

On July 1 of each year all developed plates in the laboratory, including failures, will be expressed to Washington. The plates must be carefully packed to prevent breakage. Notebooks containing records of exposures of the plates, a statement of the number of undeveloped plates on hand, and plates which have been broken must be sent at the same time. A full description of each subject photographed, together with the size of the diaphragm, length of exposure, light, hour, etc., must be recorded in the photographic notebooks provided for that purpose.[a]

All photographs must be numbered in accordance with the Service series, numbers of which appear in the photographic notebooks. The Service number will be given when requesting prints from plates on file in Washington.

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[a] In case the exposures are made by a regular photographer, no items other than a description of the subject need be entered in the photographic notebook.

Under no conditions should slides be made in the field unless the special permission of the central office shall have been obtained in every instance.

LOG SHEETS.

LOAD-DEFORMATION SCALES.

The log sheets provide for the recording of load-deformation readings directly as points on the load-deformation curve. These sheets will be used for all tests in which load-deformation readings are taken. The following scales will be used for the different tests unless better results can be secured by using other scales. The scales used must be clearly indicated on the axes of the curve.

Immediately after a test and before removing the carbon, draw in the load-deformation curve and locate the elastic limit. Record the values of the elastic limit load and deformation in the proper place on the log sheet.

	Load.	Deformation.
Main bending, 8″ by 16″ by 15′	10,000	0.4
Main bending, 5″ by 8″ by 15′	1,000	1.0
Small bending, 2″ by 2″ by 28″	400	.2
Compression parallel to grain, 6″ by 6″ by 24″	20,000	.02
Compression parallel to grain, 2″ by 2″ by 8″	4,000	.01
Compression perpendicular to grain, 8″ by 16″	4,000	.1
Compression perpendicular to grain, 2″ by 2″	1,000 2,000	.1

NOTE.—Loads are given in pounds per inch and deflections in inches per inch. The increments of load should be chosen so as to furnish about 10 points on the load-deformation curves below the elastic limit.

RECORDED QUANTITIES.

As a rule, for large beams, cross-section dimensions shall be given to the nearest 0.01 inch, lengths to the nearest 0.1 inch, deflection readings to the nearest 0.01 inch, and weights to the nearest pound. In small specimens, all dimensions shall be given to the nearest 0.01 inch and deformation readings to the nearest 0.001 inch. Weights of 1,000 grams or more shall be given to the nearest gram, and weights less than 1,000 grams to the nearest 0.1 gram. Rings per inch shall be given to the nearest 0.1; per cent of summer wood to the nearest per cent; moisture to the nearest 0.1 per cent. As a rule, calculated results shall contain three significant figures, except when the first figure is one, then four significant figures should be given.

The dimensions and measurements stated above are those which it is convenient to record. In some cases an unnecessary degree of accuracy results. In the case of quantities not specified, errors of observation and calculation of less than 1 per cent may be disregarded.

Rings per inch and summer wood shall always be measured along a radial line; that is, along a line normal to the annual rings. The average number of rings per inch will be the total number of rings intersected by the line divided by the length of the line. The average per cent of summer wood will be the total length of summer wood divided by the length of the line multiplied by 100. A pair of dividers or a special rule devised for the purpose is used in measuring summer wood.

In Form 1 beams the cross section will be divided into three parts, upper and lower quarters and middle one-half. The average rate of growth and summer wood percentage of each of these parts will be determined by measurement along a radial line drawn through its center. The averages for the whole cross section will be obtained by averaging the values for the middle one-half with the averages of the values for the upper and lower quarters.

DESCRIPTION OF DEFECTS AND FAILURES.

The terms used in describing defects and failures will be uniform and the descriptions sufficiently complete to properly classify both. A small sketch will be useful in showing the location of defects and the extent of the failure. The failure will be traced in red to distinguish it from the rest of the sketch.

The following definitions are used in the timber-test work of the Forest Service in describing defects and failures:

DEFECTS.[a]

Sound knot.—A sound knot is one which is solid across its face and which is as hard as the wood surrounding it; it may be either red or black, and is so fixed by growth or position that it will retain its place in the piece.

Loose knot.—A loose knot is one not firmly held in place by growth or position.

Pith knot.—A pith knot is a sound knot with a pith hole not more than one-fourth of an inch in diameter at the center.

Encased knot.—An encased knot is one which is surrounded wholly or in part by bark or pitch. Where the encasement is less than one-eighth of an inch in width on both sides, not exceeding one-half the circumference of the knot, it shall be considered a sound knot.

Rotten knot.—A rotten knot is one not as hard as the wood it is in.

Pin knot.—A pin knot is a sound knot not over one-half inch in diameter.

Spike knot.—A spike knot is one sawn in a lengthwise direction. The mean or average width shall be considered in measuring these knots.

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[a] These definitions, with the exception of those for checks and shakes, are taken from the Standard Specifications for the Grading of Structural Timber, adopted by the American Society for Testing Materials.

Pitch pocket.—A pitch pocket is an opening between the grain of the wood containing more or less pitch or bark.

Pitch streak.—A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well-defined streak, or where the fiber between grains—that is, the coarse-grained fiber, usually termed "spring wood"—is not saturated with pitch, it shall not be considered a defect.

Wane.—Wane is bark, or lack of wood from any cause, on edges of timber.

Shakes.—Shakes are splits in timber which usually cause a separation of the wood between annual rings.

Checks.—Checks are splits in timber, which usually cause a separation of the wood across annual rings.

FAILURES.

The term "failure" is used to designate the manner in which a specimen fails. The fractured surface is described by such adjectives as "brash" and "fibrous."

Bending.—Bending failures will be classified according to the appearance of the fractured surface and according to the manner in which the failure develops during test. The fractured surfaces may be broadly divided into brash and fibrous, the term brash indicating a chalky or punky fracture and the term fibrous indicating a fracture showing splinters. The manner in which failures develop during test will be classified as follows:

(1) Simple tension, in which the fracture is caused by the tensile stress acting parallel to the grain, as shown in figure 1.

(2) Cross-grain tension, in which the fracture is caused by a tensile force acting oblique to the grain, due to a cross grain; and a spiral grain tension when the failure is due to a spiral grain. The visible grain of the specimen does not usually indicate the presence of a spiral grain, which is often shown by slight checks along the planes of the medullary rays. But when an apparently straight-grained specimen fails, as shown in figure 2, it should be termed a spiral-grain tension.

(3) Splintering tension, in which the failure consists in a considerable number of slight tension failures. Figure 3 represents the bottom view of such a failure.

(4) Figure 4 represents a type of failure very common in brittle woods. It occurs very suddenly. The stick, however, is not always broken in two as shown in the figure. This is a form of tension failure and is called "brittle tension."

(5) Figure 5 represents a compression failure. This failure has few variations, except in that it appears at various distances from

the center of the stick. The load at which it appears, and its location, should be noted.

(6) A longitudinal shear failure is shown in figure 6. This may occur at either or both ends, and is often due to checks or shakes. In describing it, these points should be covered.

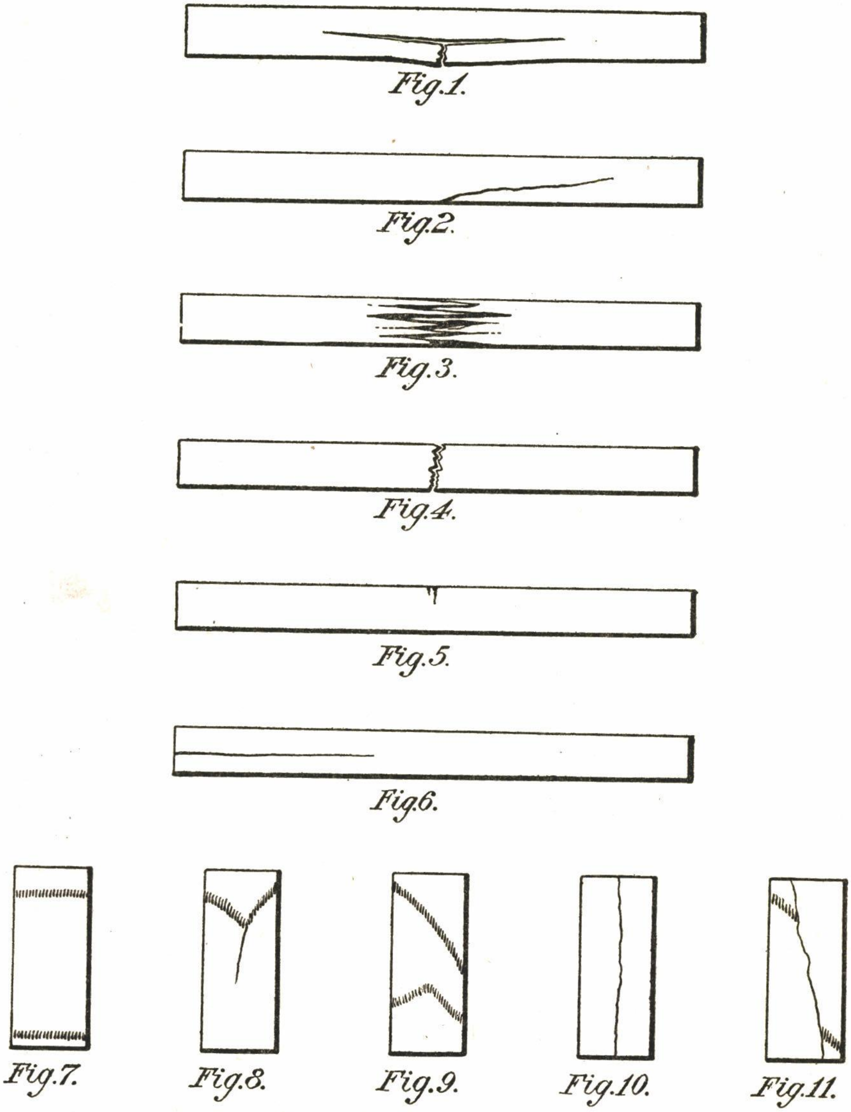

Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11.

Diagram 1.—Types of failures.

(7) Crushing at end bearings and bearing blocks should also be noted.

Compression parallel to grain.—Figures 7, 8, 9, 10, and 11 show five typical compression failures. They are designated as follows:

(1) The term "crushing" is used when the plane of rupture is approximately horizontal. It may occur at either or both ends, or in the body of the piece (fig. 7).

(2) "Wedge split" (fig. 8). This term describes itself. It is thought that the split will be radial, but this point should be noted.

(3) When the plane of rupture makes an acute angle with the axis of the piece, the term "shearing" is used. Whether the shearing plane or planes pass through an end, or through the body of the piece, should be noted (fig. 9).

(4) Splitting, as shown in figure 10, is usually an impact failure or one of kiln-dried wood, and is usually due to checks and shakes.

(5) Figure 11 represents a combination of compression and shearing parallel to the grain. It occurs in diagonally grained pieces, and should be culled as a compression test.

METHODS OF MAKING TESTS.

SPEEDS OF MACHINE.

The speeds of the testing head of the machine for the various tests are given under the descriptions of these tests. On account of the variation in the size of the specimen and the mechanical limitations in the variation of the speed of the machine it will be necessary to depart from these speeds in certain cases. A variation of 25 per cent will be allowed. Variations in the speed of the test may be caused by stretching of the belts, slippage in the gearing, or variation in the motive power. This will be eliminated as far as possible. Friction gearing will not be used to drive the load, and all belting will be kept taut and in good condition. In all cases the exact speed of the machine is to be recorded on the test blank. The following formulas are to be used in calculating the speed of descent of the movable head of the testing machine from the specified rates of deformation which are standard. In case it is necessary to adjust the results of tests to a common basis of speed, the engineer should obtain formulas and data for this purpose from the central office.

Let z = rate of fiber strain per inch of fiber length.
n = speed of movable head of machine in inches per minute.
l = span (in compression l = length of specimen).
h = height of beam.

Then

For compression parallel to the grain, $n = z\,l$.

For beams loaded at the center, $n = \frac{Z\,l^2}{6\,h}$.

For beams loaded at third points, $n = \frac{Z\,l^2}{5.4\,h}$.

TEMPERATURE.

When tests are made on material which has been subjected to extreme conditions of temperature the previous conditions of exposure should be recorded.

BENDING TESTS (LARGE BEAMS).

Preparation.—Roughly square the ends of the specimen. Weigh and measure. Measurements of the section should be made near the middle.

Sketching.[a]—The sides and ends will be marked as follows: The butt end will be marked "A" and the top end "B." Then looking at the butt end, the top side will be marked "*a*," the bottom "*c*," the right hand "*b*," and the left hand "*d*." The middle of the beam will then be located and a drawing made of the four sides and ends, showing the size and condition of defects and their location with respect to the middle and an edge of the beam; also irregularities of grain, the distribution of heartwood and sapwood, and the location of pith and annual rings on the ends. The failure should be traced on the drawing at the conclusion of the test.

A small sketch will be made, when necessary, to show the method of cutting up and utilizing the main beam after test.

Position in machine.—Place the beam in the machine with the "*a*" side on top and the center line midway between the knife-edge supports. Bearing blocks with thin metal plates, curved longitudinally to prevent damaging the beam, will be used at the points where the load is applied. Roller bearings will also be needed at these points. Ordinarily, rocking knife edges will suffice at the points of support, provision being made for sufficient bearing area to prevent local crushing.

Method of loading.—Third point loading will be used. This method of loading consists in symmetrically applying the load at two points one-third the span apart (appendix, fig. 1). The speed of the testing head of the machine in large beam tests shall be such as to produce a rate of fiber strain of 0.0007 inch per inch of outer fiber length per minute.

Measurement of deflection.—If the testing machine has a rigid head it is sufficiently accurate to measure deflections on one side of the beam. Loads will be applied at a uniform speed and the deflections read "on the run." A fine wire, kept taut by a spring or rubber band, is stretched between two small nails driven on the neutral axis vertically above the knife-edge supports. At no point should the wire touch the face of the beam. The deflections are read on a scale fixed on the neutral axis of the beam at the center, back of the wire. A mirror fastened to the scale will increase the accuracy of the readings if they are read with a reading glass. If they are read with a telescope, however, the mirror is not needed. The readings will be taken to the nearest 0.01 inch. In view of the large deflection measured and the variability of the product, this is sufficiently accurate.

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[a] To secure uniformity, outlines for all sketches will be made by means of templets.

The procedure is as follows:

(1) Place the beam in the machine.

(2) Balance the beam of the machine at zero while the timber rests on the platform.

(3) Take a reading of the wire and scale at 0 load, then apply the load continuously, taking readings of the deflection at regular increments of load. If desirable, the load may be read at regular increments of deflection. The weighing beam of the testing machine should be kept floating after the yield point is reached, and the maximum load should be noted. Record at least one deflection point after the maximum load, and in the event of a sudden failure, sketch the direction of the load-deflection curve beyond the maximum. In many cases the test should be continued after the maximum load has been passed, until complete failure results. Indicate on the load-deflection curve by number the deflection points at which the various failures occurred.

(4) Describe the failure and sketch it on the drawing made before testing, numbering the failures in the order of their occurrence.

(5) Cut two 1-inch moisture sections from the region of failure, and one 2-inch identification section, which will be filed at the laboratory. One of the moisture sections will be cut up into a sectional disk (see p. 27, diag. 2). The other one will be handled in the usual manner. Also cut and properly label the portions to be taken from the main beam for Form 2 tests.

BENDING TESTS (SMALL BEAMS).

Surface all small beams on four sides, taking care to prevent injury of the specimens by the rollers of the surfacing machine. The beams are to be cut 2 inches by 2 inches in section by 30 inches long, and tested over a 28-inch span under center loading. If specimens 30 inches in length can not be obtained, shorter lengths may be used with the approval of the central office. The supporting knife edges should be provided with roller bearings. Deflections will be measured with a deflectometer, as shown in the appendix (fig. 2). The speed of the testing head of the machine in small beam tests will be such as to produce a fiber strain of 0.0015 inch per inch of outer fiber length per minute.

Weigh and measure the specimen, describe all defects, record the rate of growth and per cent of summer wood when possible. The procedure will be the same as that for large beams, except that but one section will be cut. This section will serve for both moisture determination and identification.

COMPRESSION PARALLEL TO GRAIN.

Compression tests parallel to grain will be made on two classes of specimens, posts 24 inches in length and small clear blocks nominally 2 inches by 2 inches by 8 inches. The speed of the testing head of the machine will be such as to produce a rate of fiber strain for large-size specimens of 0.0015 inch per inch of length per minute, and for small specimens of 0.003 inch per inch of length per minute.

The procedure is as follows:

(1) Weigh and measure the specimen and describe all defects. Also, when possible, determine the rate of growth, and the per cent of summer wood. If more convenient, the specimen may be weighed directly after test.

(2) Adjust the compression collars at the standard distance apart (20 inches for large and 6 inches for small tests) (appendix, fig. 3), and place the specimen in the machine, using a spherical head to bring its upper surface parallel to the lower surface of the movable head.

(3) Apply the first increment of load, and adjust the compressometer as shown in the appendix (fig. 3).

(4) Apply load continuously until after the maximum load has been reached, taking readings at regular increments of either load or compression. Record at least one deformation point after the maximum load, and in the event of a sudden failure, sketch the direction of the load-deformation curve beyond the maximum.

(5) Describe and sketch the failure, numbering the various parts of the failure in the order of their occurrence.

(6) Cut and weigh moisture section. No identification disk will be cut from compression specimens.

COMPRESSION PERPENDICULAR TO GRAIN.

Compression tests perpendicular to grain will, in general, be made on two classes of specimens—large and small. The speed of the testing head of the machine for the large size specimens will be 0.007 inch per inch of height of specimen per minute and for the small size specimens 0.015 inch per inch of height of specimen per minute.

The procedure is as follows:

(1) Weigh and measure the specimen and describe all defects. Also, when possible, determine the rate of growth and per cent of summer wood. If more convenient, the specimen may be weighed directly after test.

(2) Mount the specimen in the machine with a bearing plate on its upper surface. For the larger tests this plate shall be 6 inches wide; for the smaller ones, 2 inches wide. The plate shall in all cases project ovêr the edges of the specimen, and in no case shall the length of the specimen be less than four times the width of the plate.

(3) Apply the first increment of load and adjust the deflectometer as shown in the appendix (fig. 4).

(4) Apply load continuously until the elastic limit has been well passed, taking compression readings at regular load increments. Note the maximum load when possible.

(5) Describe the failure.

(6) Cut and weigh moisture section.

SHEARING PARALLEL TO GRAIN.

The method found most suitable for tests of this kind is a compression load producing single shear. The tests will be made with a tool designed for the purpose, and the specimen will be arranged so as to obtain a pure shear unaccompanied by splitting of the test piece due to bending. The shearing test specimens will usually be in the form of blocks 3 by 3 by 3 inches, with a projecting lip 2 by 3 by $\frac{3}{4}$ inches, which is sheared off. It is important that the upper surface of the lip be sawed parallel to the base of the specimen. Blocks cut from 2 by 2 inch bending specimens are sometimes used. In this case the blocks are cut about 3 inches long and a projecting lip 2 by 2 by $\frac{5}{8}$ inches is sheared off. The specimens must be clear and straight grained. The projecting lip may be slightly undercut. Where the failure is not a pure shear, the test will be culled. The speed of the testing head of the machine will be 0.015 inch per minute. The portion of the projecting lip sheared off will be used as a moisture section.

The procedure is as follows:

(1) Place the shear block in the tool with its lip under the sliding plate, as shown in the appendix (fig. 5), and apply an initial load sufficient to take up the lost motion in the machine.

(2) Apply load continuously until failure. Note the maximum load and the length of time to reach it. In shearing specimens cut from the sticks the specific gravity dry, per cent of summer wood, and rate of growth of the stick will be assumed for the specimen. In specimens not taken from sticks, these quantities will be determined.

(3) Sketch failure.

(4) Trim and weigh moisture section.

SPECIAL TESTS.

The following tests will be made under special instructions issued from the central office:

IMPACT TEST.

This test will be used to determine the relative brittleness of different woods.

A machine has been devised by Dr. W. K. Hatt for making impact tests for the Forest Service.[a] The mechanical details of this machine were worked out and its construction supervised by Prof. W. P. Turner, of Purdue University. Its essential parts are: (*a*) A base or anvil weighing 3,500 pounds, allowing a specimen 5 feet long to be tested in bending; (*b*) a set of hammers of 250, 100, and 50 pounds weight, respectively, lifted by an electro-magnet and automatically released at a predetermined height by a catch which trips a trigger and breaks the electric circuit; (*c*) guides for these hammers, 7½ feet in length, surmounted by an electric motor that lifts or lowers the hammer; (*d*) a rotating drum on which a pencil attached to the hammer records a curve during the descent of the hammer; (*e*) a tuning fork, which enables the speed of the drum to be computed. This machine is shown in its essential parts in the appendix (fig. 6).

The resistance of a specimen of wood under impact is usually determined by dropping a given weight from successively increasing heights. The successive amounts of deformation and set of the specimen and rebound of the hammer are recorded on the drum. The elastic strength of the specimen is fixed at that limit at which the deflection suddenly increases. At this limit a sudden increase in the set of the specimen, as well as a maximum amount of rebound of the hammer, usually occurs.

In making the test the hammer is allowed to rest upon the specimen and a zero or datum line is drawn. The hammer is then dropped from increasing heights and records taken on the drum. A sample record is seen in the appendix (fig. 7). The deflection under the dead weight of the hammer is obtained by reference to static cross-bending tests on similar specimens.

The height of the drop at which any rupture of the specimen occurs is noted, together with other phenomena of test. Sample log sheets and calculations will be found in the appendix.

The machine is calibrated in advance to determine the proportion of the height of fall which is not effective because of friction and lag of magnet.

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[a] Described fully in the "Proceedings of the American Society for Testing Materials," Vol. VI, 1906, p. 462.

A new machine with a hammer which can be varied in weight from 500 to 1,500 pounds has been designed. This machine will be automatic and especially adapted to tests under repetitive loading.

ABRASION TEST.

The machine for making this test is a modified form of the Dorry abrasion machine, shown in the appendix (fig. 8). Small blocks of wood are fixed in the clamps and held against a revolving horizontal disk upon which is glued a commercial sandpaper, known as garnet paper, which is commonly used in factories for finishing wooden products. The wear of the standard specimen (hard maple at 12 per cent moisture) expressed in per cent of the wear of the test specimen represents the abrasive resistance of the wood. This test will be used to determine the relative hardness. In making the test, a specimen of the wood chosen as a standard is held in one clamp and the sample to be tested in the opposite clamp, so that a comparison of the two will not be affected by any change in the conditions of the surface of the garnet paper due to wear. The speed of rotation is 68 revolutions per minute. The test is continued until the standard maple specimen is worn a specified amount that varies with the kind of wood under test. The area of wood under abrasion is 2 by 2 inches. It is important that the standard and the test specimen be of the same cross section, and that they be placed in the clamps so as to be worn by the same portions of the sandpaper. The weight by which the specimen is forced on the sandpaper disk is 26 pounds (that is the weight of the clamp on the machine described in the appendix).

TORSION TEST.

The torsion test is useful in determining the relative length of fiber and toughness of the wood. It is made in a standard Riehlé-Miller torsional testing machine or its equivalent. This torsion test will be made upon but few specimens. The test pieces will be cylindrical, 1½ inches in diameter and 18 inches gauge length, with squared ends 4 inches long joined to the cylindrical portion with a fillet. The load will be applied continuously.

The procedure is as follows:

(1) Measure dimensions, rings per inch, and summer wood, and locate all knots and defects.

(2) Apply load at the rate of 22° per minute and read load and deformation until failure occurs. The Olsen troptometer, or a similar instrument, should be used for measuring the deformation.

(3) Describe the character of the failure.

(4) Cut out the cylindrical center of a length equal to the gauge length, and weigh.

(5) Determine the moisture by the disk method.

SPIKE-PULLING TEST.

Spike-pulling tests apply to problems of railroad maintenance, and the results are used to compare the spike-holding power of various woods, both untreated and treated with different preservatives, and the efficiency of various forms of spikes. Special tests are made in which the spike is subjected to a transverse load applied repetitively by a blow.

Spike-pulling tests will in all cases be made upon full-sized ties. The head of the spike will have a ½-inch clearance above the surface of the tie. Dog spikes will be driven into the tie by an experienced operator, and screw spikes will be screwed into holes the diameter of which is the diameter of the spike at the root of the thread. The common spike will be driven but once. The spikes will not be driven into knots and will be a sufficient distance from the end of the tie to avoid splitting. The minimum spacing of holes will be 6 inches.

In pulling, the spikes shall be gripped in the type of holder shown in the appendix (fig. 9), and pulled in the direction of their length. A scale will be so adjusted that the distance through which the spike is pulled may be measured. Load-distance readings will be taken for each 0.1 inch pull, and continued until the load has fallen to one-half of the maximum. These readings will be plotted in the usual manner. The log sheet will contain, besides the load-distance curve, a sketch showing the end section of the tie and the face from which the spike was drawn. The manner of failure will be shown on the sketch, as well as the location and size of all defects near the spike. The rate of growth, per cent of summer wood, and moisture content of the tie will be determined and recorded on the log sheet. The weight and dimensions of the tie will also be recorded.

The speed of the movable head of the testing machine will be 0.3 inch per minute.

The results will be calculated on the basis of—

(*a*) Area of surface in contact with the wood.
(*b*) Per inch of length of spike.
(*c*) Maximum load.

TENSION TEST.

It is difficult to secure significant results in tension parallel to the grain, accordingly this test will be used only to a limited extent. The significance and application of the method of making tension tests is at present under investigation.

SHRINKAGE TEST.

To determine the relative shrinkage of various woods and factors for calculating the dry specific gravity standard shrinkage specimens will be 3 by 3 by 3 inches in size, cut with the grain parallel to one side. Each side of the specimen will be marked with a small circle at its center. Shrinkage measurements will be made on these circles with micrometer calipers.

At the time the specimen is cut a moisture disk will be taken adjacent to it, so that the moisture content of the specimen may be approximately determined. Shrinkage measurements will be made for every 5 per cent loss in moisture as determined by loss in weight. The log-sheet shrinkage record should show the rate of growth and per cent of summer wood of the specimen. The weight of the specimen will be recorded each time a set of measurements is made. At the time the specimen is cut a sketch of the end section will be made. This sketch should have entered upon it sufficient measurements so that the radius of curvature of the annual rings may be calculated.

Specimens should be dried as carefully as possible to avoid casehardening and excessive drying at the ends. When the specimen has been thoroughly dried a final moisture determination will be made upon it.

Special shrinkage tests will also be made on full-sized market products.

COLUMN TEST.

This test will be undertaken as soon as a machine of sufficient size and capacity can be secured.

DETERMINATION OF MOISTURE.

Moisture determinations will be made on 1-inch sections taken from the test specimens.

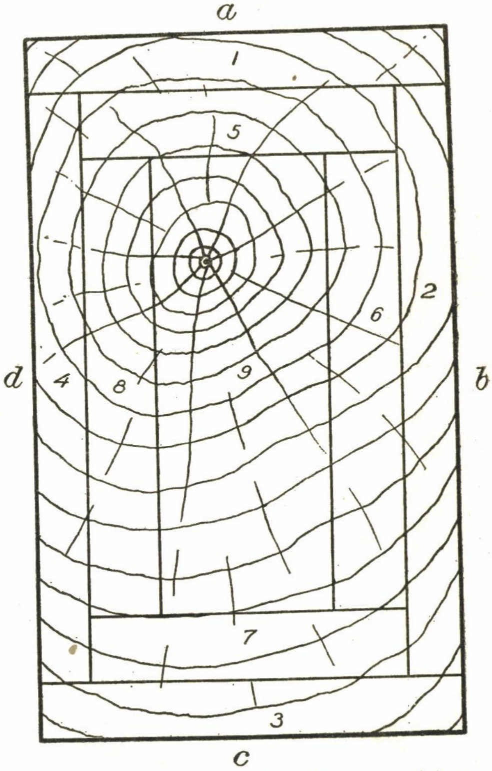


DIAGRAM 2.—Method of cutting up moisture distribution sections.

In cases where it is desirable to determine the distribution of moisture in the cross section, a 1-inch section will be cut into nine pieces (see diagram 2) and a moisture determination made on each piece. These pieces will be so proportioned that the area of the section will be divided into three approximately equal areas; that is, area 9=area (1+2+3+4)=area (5+6+7+8).

The procedure is as follows:

(1) Immediately after sawing, remove loose splinters and weigh each section or piece of section.

(2) Put into a drying oven at 100° C., and dry until the variation in weight is less than 0.5 per cent for a period of twenty-four hours.

(3) Weigh.

(4) The loss in weight expressed in per cent of the dry weight will indicate the moisture content of the specimen from which the section was cut.

RECORDS.

In addition to the regular routine records, each laboratory will keep a diary in which will be recorded any items of local interest.

HANDLING OF DATA.

As often as required, at least once a month, the engineer in charge will send to the central office the original log sheets of all tests and duplicate laboratory moisture-record cards.

It is intended that routine calculations be made at the central office. In the case of shear-test cards and laboratory moisture-record cards, however, the data will be worked up at the laboratories and completed duplicate cards sent to the central office.

When the results are calculated at the central office, test cards will be sent to the laboratory from which the data were received, where they will be filed.

REPORTS.

Complete monthly reports stating the number of tests of various kinds made on the different shipments, other work accomplished at the laboratory, and when possible, tentative conclusions drawn from the results will be sent to the central office.

SAMPLE MONTHLY REPORT.

MONTHLY REPORT.

PURDUE LABORATORY, JANUARY, 1907.

Status of shipments.

Shipment 15 (oak and southern pine wagon poles):			
Tests made—			
Bending	2×2×30	43	
Compression parallel to grain	2×2×8	40	83
Remaining tests per working plan—			
Air-dry, Form 2			130

Shipment 25 (tamarack):					
Tests made—					
Impact bending	2×2×30	105			
Compression parallel to grain	2×2×8	119			
Compression parallel to grain	4×4×16	23			247
Remaining tests per working plan—					
Air-dry, Form 1		140			
Air-dry, Form 2		400		540	
Green, Form 2			200		
Shipment 26 (loblolly pine):					
Remaining tests per working plan—					
Air-dry, Form 1		12			
Air-dry, Form 2		240		252	
Green, Form 2			150		
Shipment 27 (Douglas fir wagon poles):					
Remaining tests per working plan—					
Air-dry, Form 3		10			
Air-dry, Form 2		40		50	
Tests made					330
Air-dry specimens to be tested				972	
Green specimens to be tested			350		
Moisture determinations		240			

SHIPMENTS RECEIVED.

Shipment 26: Twelve North Carolina pine beams size 8″ by 16″ by 16′, shipped from ——— Lumber Co., Charleston, S. C.

Shipment 27: Ten wagon poles from ——— Company, La Fayette, Ind.

EXPENSES.

Salaries (John Doe and T. N. Brown)		$------	
To be paid from John Doe's authorization.			
Expense account of John Doe (Form 4)		------	
F. C. Black (Form A)	$------		
N. T. Green (Form A)	------		

Total expense at laboratory			$------
Remaining on John Doe's authorization			------
Distribution of expenses according to projects:			
Vehicle woods			$------
Tamarack			------

MISCELLANEOUS NOTES.

A series of tests in bending and compression parallel to the grain was made on specimens cut from the wagon poles and cultivator poles. These tests uphold the results of the tests on the full-sized poles.

Impact tests were made on 2″×2″×30″ pieces of tamarack and Norway pine. The average height of drop withstood by the tamarack was greater than that withstood by the Norway pine.

A "Report on spoke tests" and a "Report on cultivator pole tests" were submitted.

A number of tests on wood specimens were made on a vibratory machine erected by Purdue University. The test specimen was in the form of a cylinder about 1 inch in diameter and 1 foot long, held firmly at one end by clamps and the other end made to move on the circumference of a circle whose center is on the center line of the clamps. This movement causes a reversal of stress in the test piece.

A working plan for tests on hickory was submitted. M. D. White and G. R. Field visited the laboratory. Plans for future work were discussed, especially the working plan for hickory. It is planned to investigate both the relative strength of the different species and the effect of the locality of growth on strength.

T. N. Brown was away on leave of absence January 10–15.

Preliminary or progress reports will be prepared as soon as sufficient data have been obtained to furnish indicative results. This applies especially to cooperative work. In no case will reports be embodied in letters, and in all cases they must be signed and dated. At the completion of work covered by a working plan, the engineer in charge is expected to prepare and submit to the central office a complete report of the investigation.

DIAGRAMS AND SUMMARIES.

All diagrams will be made upon paper sufficiently thin to blueprint readily. Large diagrams will be made upon coordinate paper 22 inches wide, and, for convenience in filing, not longer than 28 inches. Small diagrams will be made upon standard 7 by 10 inch coordinate paper.

Special forms will be provided for summary tables. In general, however, all summaries and diagrams will be made at the central office.

FILES.

The following files, with their necessary card indexes, will be kept at each laboratory:

(*a*) Complete description of all shipments received.

(*b*) Working plans for each piece of work undertaken.

(*c*) Carbon copies of all log sheets of tests made at the laboratory, filed according to shipment.

(*d*) Complete test card files. These should be grouped according to shipments.

(*e*) Laboratory moisture record card.

(*f*) Photographic print file.

(*g*) Summary sheets, diagrams, etc.

(*h*) General information.

APPENDIX.

EXPLANATORY NOTE.

On account of inquiries regarding the significance of the various functions, such as the elastic limit, modulus of rupture, modulus of elasticity, etc., quoted in the publications of the Forest Service, the following explanation is given:

The elastic limit is a measure of the elastic strength of wood, whether in compression (as a post) or in bending (as a beam). Below this limit of stress the material suffers no permanent deformation under a test load, but comes back to its original form when the load is removed.

The modulus of rupture is a measure of the breaking strength of a beam. The crushing strength is a measure of the breaking strength of a post.

The modulus of elasticity is a measure of the stiffness of wood. A large modulus indicates a stiff material, one that deforms but little under the action of a load.

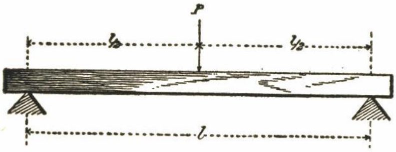
The modulus of resilience is a measure of the "springiness" of the material. For instance, hickory has a large modulus of resilience.

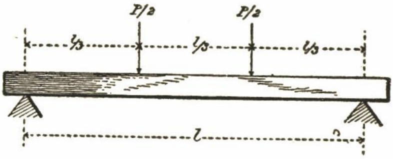
FORMULAS USED IN COMPUTATIONS.

LEGEND.

A = area of cross section, square inches.
B = area under plate, square inches.
$C.S$ = crushing strength, pounds per square inch.
E = modulus of elasticity, pounds per square inch.
$E.L$ = fiber stress at elastic limit, pounds per square inch.
G = modulus of elasticity in shear, across the grain, pounds per square inch.
J = greatest calculated longitudinal shear, pounds per square inch.
K = 27.7 when weight is in pounds.
K = 0.061 when weight is in grams.
M = moment of torsion at elastic limit, inch-pounds.
$M.R$ = modulus of rupture, pounds per square inch.
$M.Ri$ = modulus of elastic resilience, inch-pounds per cubic inch.
P = maximum load, pounds.
P' = load at elastic limit, pounds.
S = dry specific gravity.
T = outer fiber torsional stress at elastic limit, pounds per square inch.
W = weight of specimen, pounds.
Δ = total deflection or compression at elastic limit, inches.
a = angle measured by troptometer at elastic limit, in degrees.
b = width, inches.
c = diameter of torsion specimen, inches.
d = distance between centers of collars, inches.
f = gauge length of torsion specimen, inches.
h = height, inches.
l = span, inches (compression, l=length).

BENDING.





Load applied at center:

$$J.=\frac{0.75\times P}{b\times h}$$

$$M.\ R.=\frac{1.5\times P\times l}{b\times h^2}$$

$$E.\ L.=\frac{1.5\times P'\times l}{b\times h^2}$$

$$E.=\frac{P'\times l^3}{4\times b\times h^3\times\Delta}$$

$$M.\ Ri.=\frac{P'\times\Delta}{2\times b\times l\times h}$$

Load applied at third points:

$$J.=\frac{0.75\times P}{b\times h}$$

$$M.\ R.^{a}=\frac{l\times(P+0.75\ W)}{b\times h^2}$$

$$E.\ L.^{a}=\frac{l\times(P'+0.75\ W)}{b\times h^2}$$

$$E.=\frac{P'\times l^3}{4.7\times b\times h^3\times\Delta}$$

$$M.\ Ri.=\frac{0.435\times P'\times\Delta}{l\times b\times h}$$

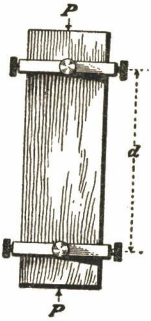
$$S.=\frac{\text{wet weight}\times K}{(1+\text{moist})\times\text{vol. in cu. in.}}$$

Compression parallel to grain:

$$C.\ S.=\frac{P}{A}$$

$$E.\ L.=\frac{P'}{A}$$

$$E.=\frac{P'\times d}{A\times\Delta}$$



Compression perpendicular to grain:

$$E.\ L.=\frac{P'}{B}$$

Shear parallel to grain:

$$\text{Shear}=\frac{P}{A}$$

Torsion.

$$T.=\frac{5.1\times M}{c^3}$$

$$G.=\frac{114.6\times T\times f}{a\times c}$$

---

[a] In large beams the weight should be taken into account in calculating the fiber stress. Three-fourths of the weight is added to the load for this reason.

Form 170
(Supersedes Forms 610 and 611)

Timber Test Log Sheet

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Working Plan No. 7.

Laboratory Purdue

Date 7-26-07.

Ship. No. 41

Stick No.

Lab. No. 14339.

Piece No. 11

Mark

Species Shortleaf pine

Kind of Test Bending

Grade Merchantable

Group III

Loading Third Point

Span 180"

Distance between collars

Width of plate

Machine 100,000 lbs. Olsen

Speed of Mach. 0.25 in per min.

Height 16".05

Width 7".94

Length 197".0

Cross-section

Weight 548 lbs.

Rings per inch 11.0

Sap 0%

Summer Wood 26%

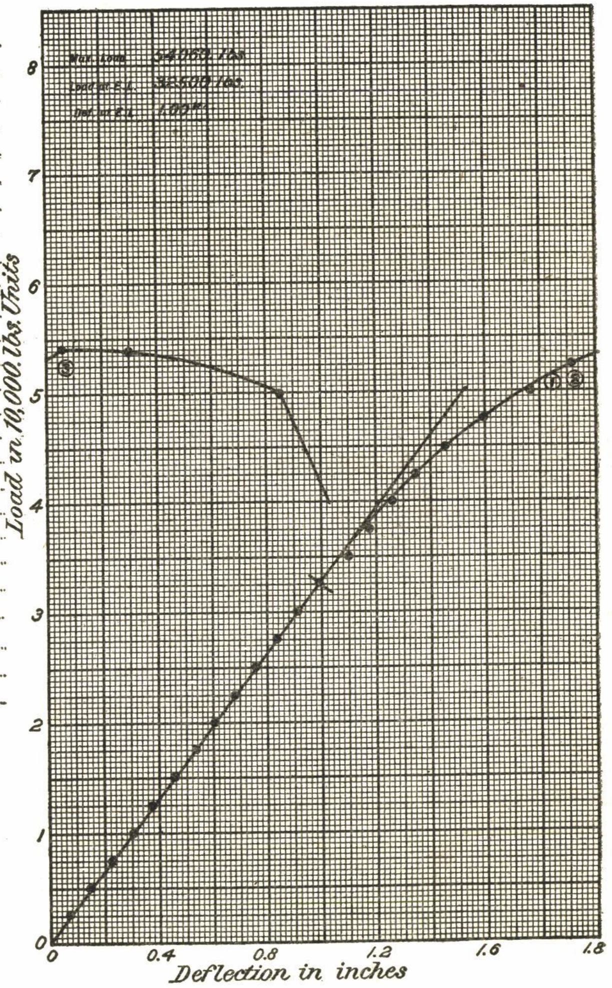
Seasoning Green

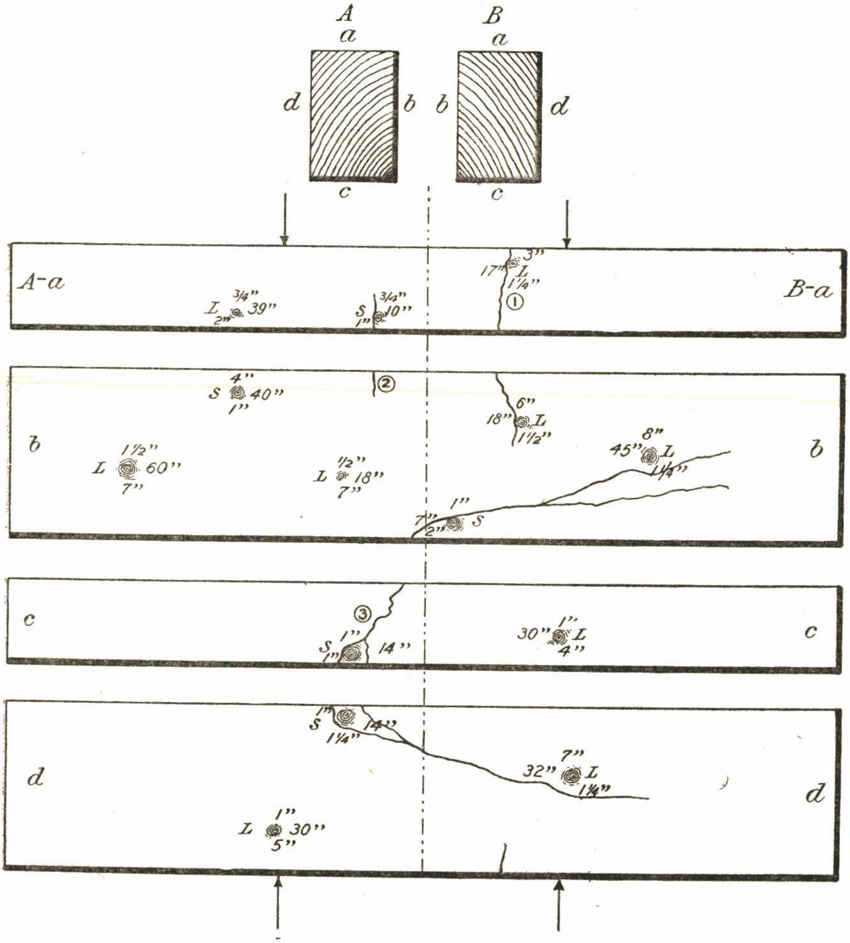
Moisture 47.2%

Kind of failure Compression and slightly cross-grained tension.

Remarks Compression at 50,000 lbs load.

Sketch




A
a
d
b
c
B
a
b
d
c
A-a
3/4"
L
39"
2"
S
3/4"
10"
1"
3"
17"
L
1¼"
①
B-a
4"
S
40"
1"
②
6"
18"
L
1½"
b
1½"
L
60"
7"
½"
L
18"
7"
8"
45"
L
1¼"
b
1"
7"
2"
S
③
c
1"
S
1"
14"
30"
1"
L
4"
c
1"
S
14"
1¼"
d
7"
32"
L
1¼"
d
1"
L
30"
5"

Form 176
(Supersedes Forms 610 and 611)

Timber Test Log Sheet

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Working Plan No. 8.

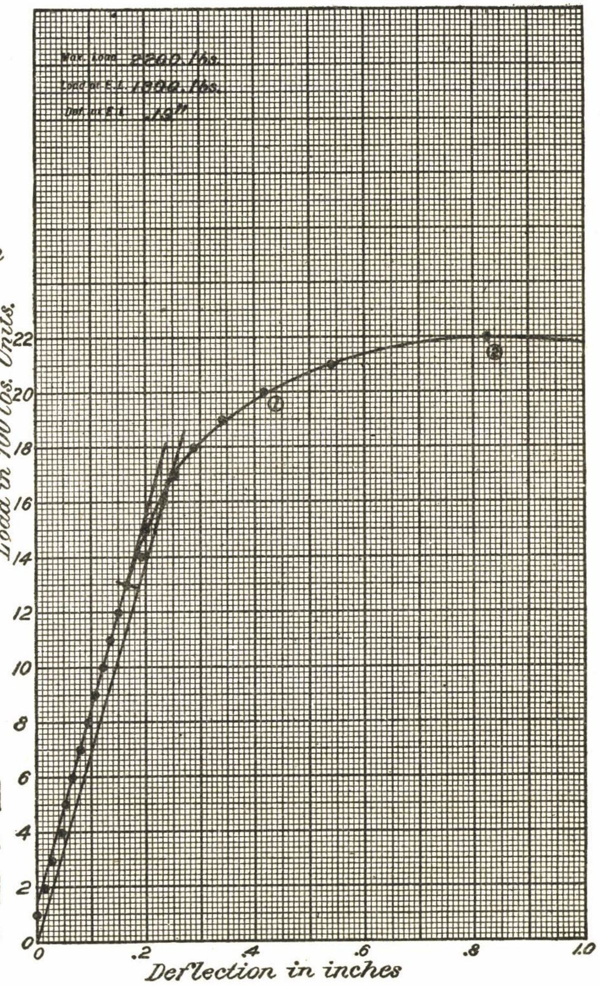
Ship. No. 42 Stick No. 5

Laboratory Berkeley Date 12-13-07.

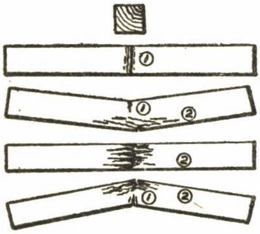
Lab. No. 15969.

Piece No. 2 Mark

Species Tanbark Oak
Kind of Test Bending
Grade Clear
Group
Loading Center
Span 28"
Distance between collars
Width of plate
Machine 30,000 lbs. Olsen
Speed of Mach. .09 in per min.
Height 2.02"
Width 2.01"
Length 30.06"
Cross-section
Weight 2150.0 grams
Rings per inch 18
Sap 0%
Summer Wood 58%
Seasoning Green
Moisture 67.8%
Kind of failure Slight comp at center and splintering tension.
Remarks Tension at Max. load. Defl. .82"



Sketch



Form 176
(Supersedes Forms 610 and 611)

Timber Test Log Sheet

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Working Plan No. 1.

Ship. No. 25 Stick No.

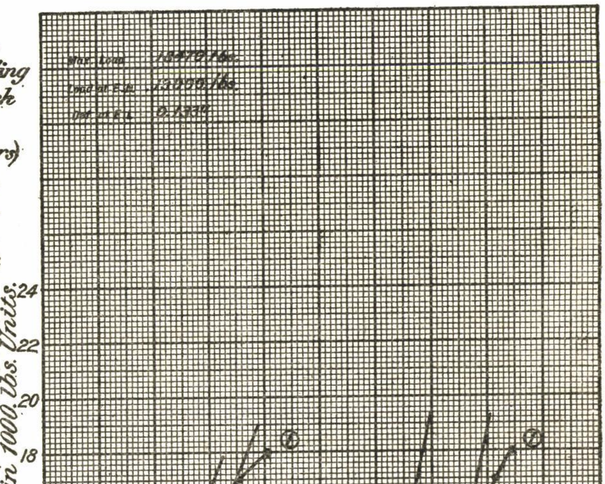
Laboratory Purdue Date 8-16-06.

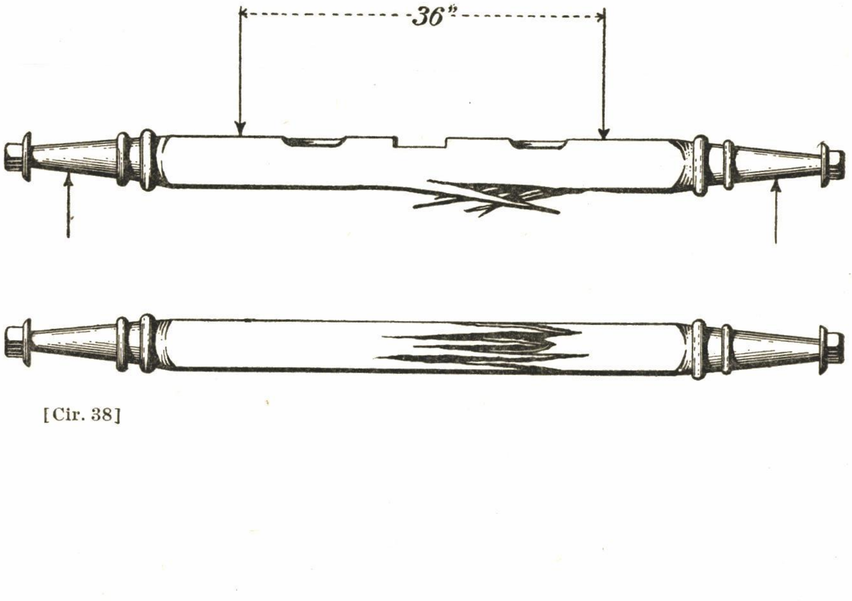
Lab. No. 12417. Piece No. 37 Mark M

Species Hickory
Kind of Test Wagon axle-Bending
Grade Average seasoned stock
Group Thimble skein
Loading 2-point (36" centers)
Span 54"
Distance between collars
Width of plate
Machine 200,000 lbs. Riehle
Speed of Mach. .10 in per min.
Height 4.36"
Width 3.35"
Length 66.5"
Cross-section
Weight 50 lbs.
Rings per inch 17
Sap 85 %
Summer Wood 55 %
Seasoning Air dried
Moisture 12.0 %
Kind of failure Tension from skein to skein.

Remarks After test:-
Load = 5710 lbs.
Wire defl. = 2.76"

Sketch





[Cir. 38]

Form 176
(Supersedes Forms 610 and 611)

Timber Test Log Sheet

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Working Plan No. 8.

Ship. No. 41 Stick No. 2

Laboratory Seattle Date 8-15-07.

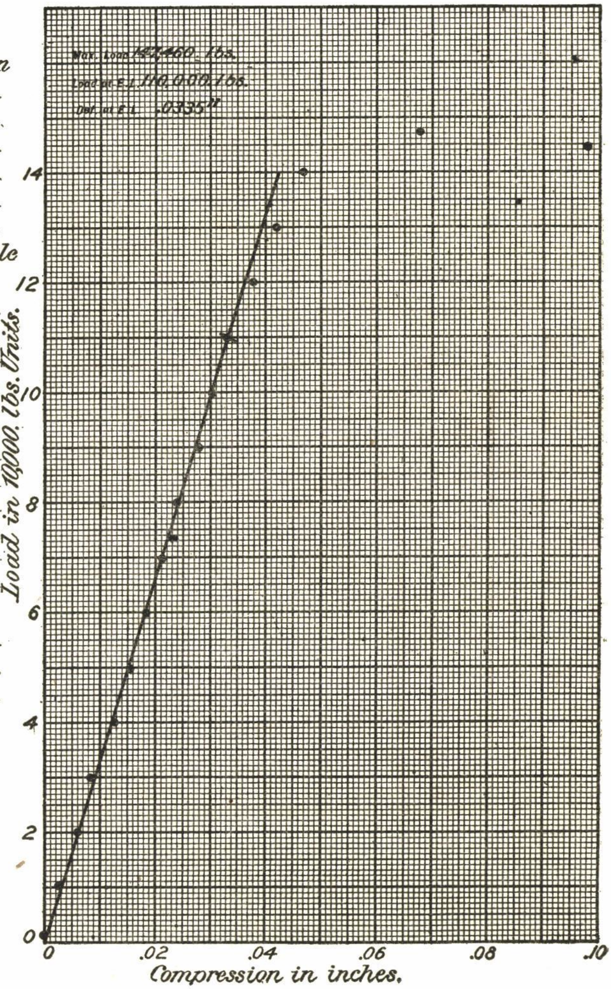
Lab. No. 14526.

Piece No. 71 Mark 1

Species Western Hemlock
Kind of Test Com. ll to grain
Grade See sketch
Group
Loading
Span
Distance between collars 20"
Width of plate
Machine 200,000 lbs. Riehle
Speed of Mach. .065 in. per min.
Height
Width
Length 24"
Cross-section 7.90" X 5.05"
Weight 21¼ lbs.
Rings per inch 15
Sap 5%
Summer Wood 39%
Seasoning Green
Moisture 43.3%
Kind of failure Crushing through body

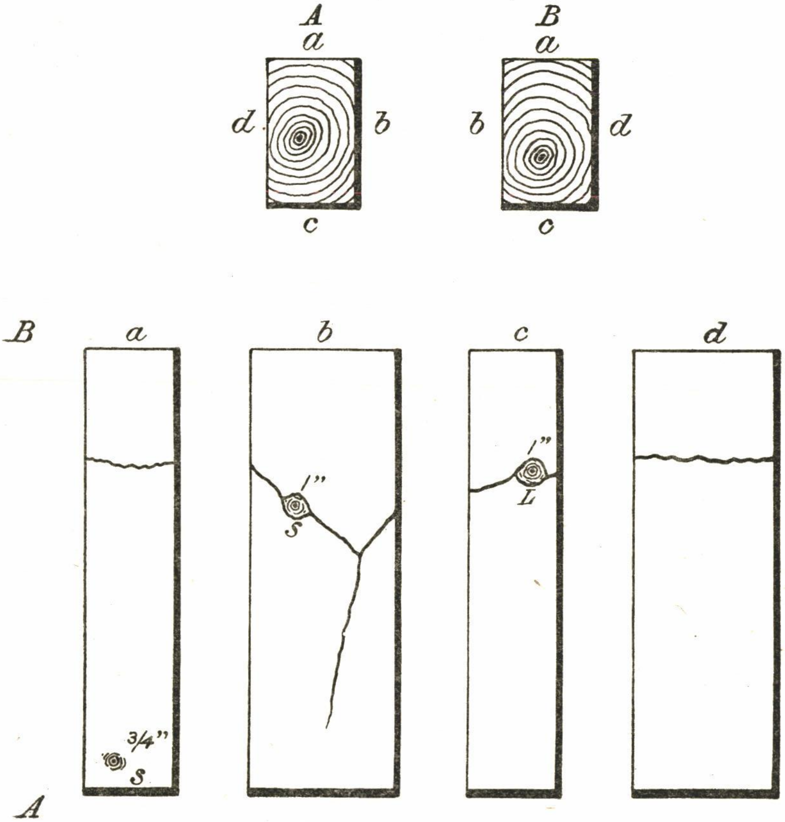
Remarks

Sketch



Max. Load 147,460 lbs.
Load at E. L. 110,000 lbs.
Def. at E. L. .0335"

[Cir. 38]


A
a
d
b
c
B
a
b
d
c
B
a
b
c
d
1"
S
1"
L
3/4"
S
A

Form 176.
(Supersedes Forms 610 and 611)

Timber Test Log Sheet

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Working Plan No. 8.

Ship. No. 2 Stick No. 5

Laboratory Eugene Date 8-16-07.

Lab. No. 3459.

Piece No. 63 Mark A

Species Douglas fir

Kind of Test Com. ‖ to grain

Grade Clear

Group

Loading

Span

Distance between collars 6"

Width of plate

Machine 30,000 lbs. Olsen

Speed of Mach. .03 in. per min.

Height

Width

Length 7.97"

Cross-section 1.99" X 1.97"

Weight 281. grams

Rings per inch 8

Sap 0%

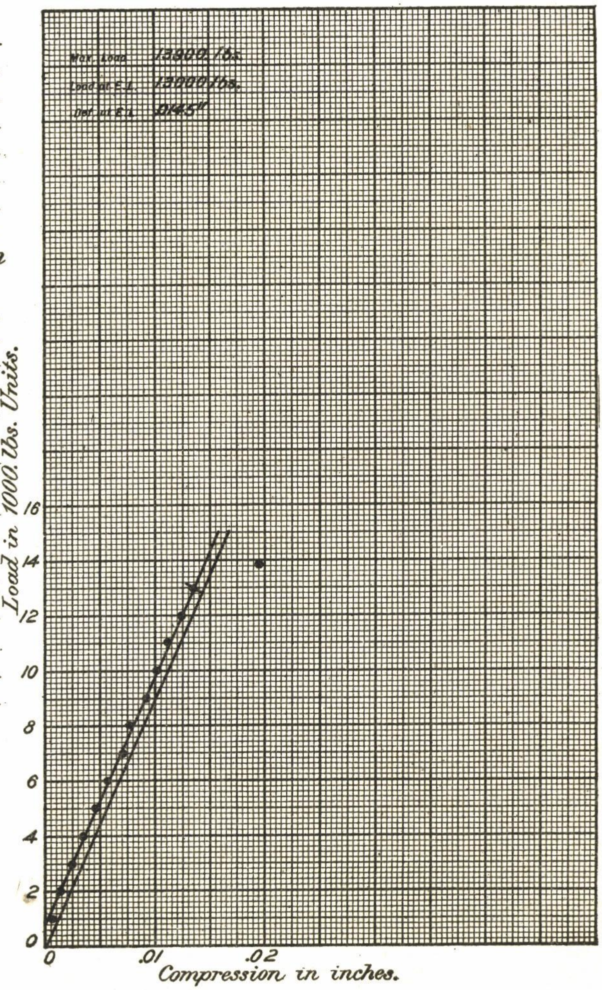
Summer Wood 34 %

Seasoning Green

Moisture 29.1 %

Kind of failure Crushing at end and shearing.

Remarks

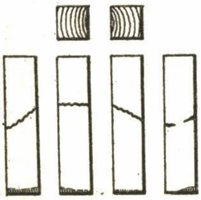


Max. Load 13900 lbs.

Load at E.L. 13000 lbs.

Def. at E.L. .0145"

Sketch



Form 176
(Supersedes Forms 610 and 61T)

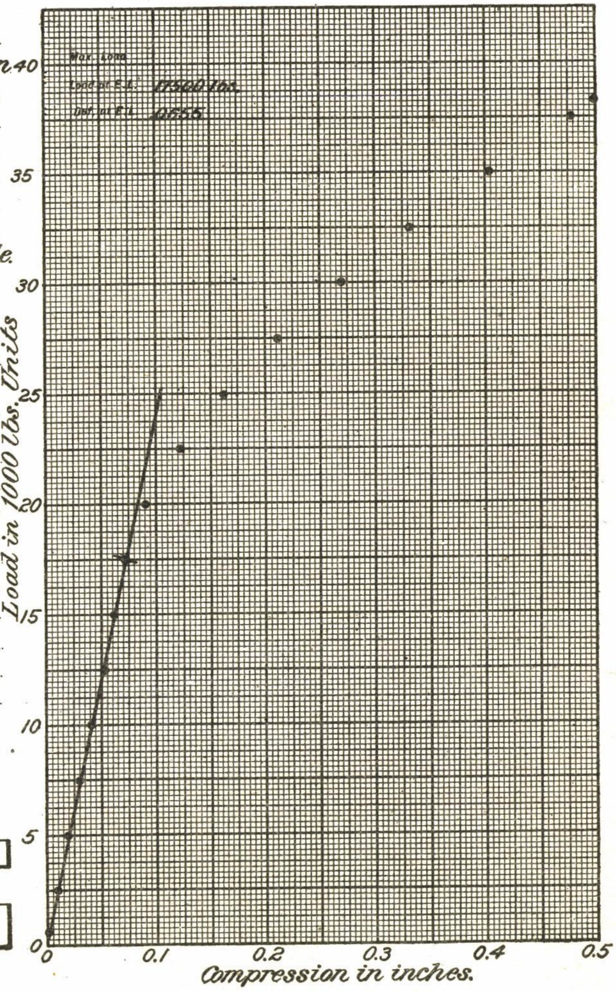
Timber Test Log Sheet

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

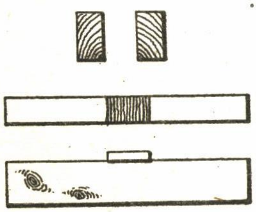
Working Plan No. 7.
Laboratory Purdue
Date 7-29-07.
Lab. No. 14360
Ship. No. 41
Stick No. 1
Piece No. 10
Mark A

Species Shortleaf pine
Kind of Test Com. ⊥ to grain
Grade See sketch
Group
Loading
Span
Distance between collars
Width of plate 6"
Machine 200,000 lbs Riehle.
Speed of Mach. .065 in per min.
Height 16.08"
Width 7.90"
Length 30.10"
Cross-section
Weight 86.0 lbs.
Rings per inch 14.
Sap 0%
Summer Wood 45%
Seasoning Green
Moisture 33.1%
Kind of failure Split at one end

Remarks


Max. Load
Load at E.L. 17500 lbs.
Def. at E.L. .0555

Sketch



SAMPLE LOG SHEETS.

Form 239.
Shipment No. *Y–14.*

Sheet No. *1,*
Date, *11–18–07.*

U. S. DEPARTMENT OF AGRICULTURE,

FOREST SERVICE.

WOOD UTILIZATION—TIMBER TESTS.

YALE LABORATORY.

Fiber saturation point and moisture strength relations of incense cedar.

[Nominal size of specimens 1" x 1" x 4".]

Stick No.	Lab. No.	Rings per inch.	Per cent of sap.	Per cent of moisture.	Cross section.	Maximum load.	Crushing strength at max. load.	Time required to make test.	Weight at test.	Position of failure.
					Inches.	Pounds.	Lbs. per sq. in.		Grams.	
1–7–G..	*2881*	*10.0*	*0*	*27.6*	*1.00×1.01*	*3,440*	*3,410*	*2' 30"*	*29.6*	*In body.*
2–7–G..	*2882*	*11.0*	*0*	*26.8*	*1.01×1.01*	*3,030*	*2,970*	*2' 50"*	*28.5*	*At end.*
3–7–G..	*2883*	*14.0*	*0*	*27.1*	*1.00×1.01*	*4,070*	*4,030*	*2' 40"*	*30.2*	"
4–7–G..	*2884*	*9.0*	*0*	*22.9*	*1.01×1.01*	*2,930*	*2,870*	*2' 40"*	*23.7*	"
5–7–G..	*2885*	*20.0*	*0*	*24.6*	*1.01×1.01*	*3,580*	*3,510*	*2' 40"*	*30.2*	*In body.*
6–7–G..	*2886*	*20.0*	*0*	*25.0*	*1.01×1.01*	*3,260*	*3,200*	*2' 40"*	*28.3*	*At end.*
7–7–G..	*2887*	*15.0*	*0*	*24.3*	*1.01×1.01*	*3,660*	*3,590*	*2' 40"*	*29.8*	"
8–7–G..	*2888*	*23.0*	*0*	*25.0*	*1.01×1.01*	*3,230*	*3,170*	*2' 00"*	*26.3*	*In body.*
9–7–G..	*2889*	*21.0*	*0*	*20.3*	*1.00×1.01*	*4,420*	*4,380*	*2' 50"*	*31.0*	*At end.*
1–16–G.	*2890*	*9.0*	*100*	*79.3*	*1.01×1.01*	*3,270*	*3,210*	*3' 00"*	*41.4*	*At end.*
2–16–G.	*2891*	*21.0*	*100*	*48.4*	*1.00×1.01*	*4,240*	*4,200*	*3' 20"*	*37.9*	*In body.*
3–16–G.	*2892*	*26.0*	*100*	*41.4*	*1.00×1.01*	*3,550*	*3,510*	*3' 30"*	*32.8*	*At end.*
4–16–G.	*2893*	*17.0*	*100*	*24.3*	*1.00×1.01*	*3,010*	*2,980*	*3' 50"*	*25.7*	"
5–16–G.	*2894*	*31.0*	*100*	*36.8*	*1.00×1.01*	*3,660*	*3,620*	*3' 20"*	*31.8*	"
6–16–G.	*2895*	*20.0*	*100*	*67.9*	*1.00×1.00*	*3,000*	*3,000*	*3' 40"*	*35.6*	*In body.*
7–16–G.	*2896*	*20.0*	*100*	*25.9*	*1.01×1.01*	*3,600*	*3,530*	*3' 40"*	*29.6*	"
8–16–G.	*2897*	*18.0*	*100*	*121.8*	*1.01×1.01*	*3,460*	*3,390*	*3' 40"*	*49.0*	*At end.*
9–16–G.	*2898*	*27.0*	*100*	*46.4*	*1.01×1.01*	*4,730*	*4,640*	*3' 30"*	*40.6*	"

Speed of machine 0.013" per min.
Specimens tested as cut.

SAMPLE DATA CARDS.

Form 179

BENDING

41 (Shipment No.) (Stick No.) *14339* (Lab. No.)

11 (Piece No.) (Mark) Laboratory *Purdue* *7* (Working plan No.)

Species *Shortleaf pine* Loading *Third point* Date *7-26-07* Weight *548 lbs.*

Length *197.0″* Width *7.94″* Height *16.05″* Span *180″* Grade *Merch.*

Seasoning *Green*

	F. S. at E. L.	M. of R.	M. of E.	Shear.	E. Resil.	Sp. Gr.	
As tested	*2850*	*4750*	*1960*	*318*	*.704*	*.495*	
Dry						*.346*	

Moisture[a] *47.2%* Rings: Up. $\frac{1}{4}$ *9.6* Mid. $\frac{1}{2}$ *10.8* Low. $\frac{1}{4}$ *12.8* Avg. *11.0%*

Sap *0%* Sum. wood: Up. $\frac{1}{4}$ *22* Mid. $\frac{1}{2}$ *25* Low. $\frac{1}{4}$ *32* Avg. *26%*

Defects *See sketch on back of log sheet* Group

Manner of failure *Compression and slightly cross-grained tension.*

---

[a] In case sectional disk is cut the moisture per cent of each section should be recorded on back of test card.

Form 179

BENDING

42 (Shipment No.)

5 (Stick No.)

15969 (Lab. No.)

2 (Piece No.)

(Mark)

Laboratory *Berkeley*

8 (Working plan No.)

Species *Tanbark oak* Loading *Center* Date *12-13-07* Weight *2150.0 gms.*

Length *30.06″* Width *2.01″* Height *2.02″* Span *28″* Grade *Clear*

Seasoning *Green*

	F. S. at E. L.	M. of R.	M. of E.	Shear.	E. Resil.	Sp. Gr.	
As tested	*6650*	*11260*	*2260*	*407*	*1.09*	*1.072*	
Dry						*.640*	

Moisture *67.8%* Rings: Up. ¼ Mid. ½ Low. ¼ Avg. *18*

Sap *0%* Sum. wood: Up. ¼ Mid. ½ Low. ¼ Avg. *58%*

Defects *None* Group

Manner of failure *Slight compression at center and splintering tension. Tension at max. load. Defl .82.″*

Form 171 **COMPRESSION PARALLEL TO GRAIN**

41 (Shipment No.) *2* (Stick No.) *14526* (Lab. No.)

71 (Piece No.) *A* (Mark.) Laboratory *Seattle* *8* (Working plan No.)

Species *Western hemlock* Date *8-15-1907*.

Length *24.0″* Cross section *5.05″×7.90″* Weight *24¼#*

Moisture *43.3%* Rings per inch *15* Sap *5%* Summerwood *39%*

Defects [a] *See sketch on log sheet*

	Crush. St. at E. L.	Max. Crush. St.	M. of E.	Sp. Gr.	
As tested	*2760*	*3690*	*2040*	*.612*	
Dry				*.429*	

Remarks *Crushing through body.*

Form 171 **COMPRESSION PARALLEL TO GRAIN**

2 (Shipment No.) *5* (Stick No.) *3459* (Lab. No.)

63 (Piece No.) *A* (Mark.) Laboratory *Eugene* *8* (Working Plan No.)

Species *Douglas fir* Date *8-16-1907*

Length *7.97″* Cross section *1.99″×1.97″* Weight *281.0 gms.*

Moisture *29.1%* Rings per inch *8.0* Sap *0%* Summerwood *34%*

Defects [a] *See sketch on log sheet*

	Crush. St. at E. L.	Max. Crush. St.	M. of E.	Sp. Gr.	
As tested	*3320*	*3570*	*1372*	*.549*	
Dry				*.425*	

Remarks *Failed by crushing at end.*

---

[a] Enter such explanatory remarks as clear, knotty, see sketch on log sheet, etc.

Form 182

COMPRESSION AT RIGHT ANGLES TO GRAIN

41 (Shipment No.)
1 (Stick No.)
14360 (Lab. No.)

10 (Piece No.)
A (Mark.)
Laboratory *Purdue*
7 (Working Plan No.)

Species *Shortleaf pine*
Date *7-29-1907*

Length *30.10″*
Height *16.08″*
Stress area *6.0″×7.9″*

Moisture *33.1%*
Rings per inch *14*
Weight *86.0 lbs.*
Summerwood *45%*

Sap *0%*
Defects *See sketch on log sheet*

	Crush St. at E. L.	Sp. Gr.		
As tested	370	.623		
Dry		.468		

Remarks: *Failed by crushing. Split at one end.*

Form 180

SHEARING

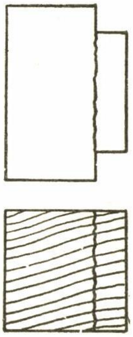
41 (Shipment No.)
8 (Stick No.)
15303 (Lab. No.)

32 (Piece No.)
B (Mark.)
Laboratory *Purdue*
8 (Working Plan No.)

Species *Shortleaf pine*
Date *9-12-1907*

Kind of shear *Radial*
Weight *281.8 gms.*
Sap *100%*

Moisture *82.6%*
Rings per inch *10*
Summerwood *36%*

	Max. load.	Shearing area.	Shear str.	Specific gravity.	Sketch.
As tested	4390	2.04″×2.98″	722		

Remarks

SAMPLE MISCELLANEOUS CARDS.

LABORATORY NUMBER AND MOISTURE CARD.

Form 296.
(Supersedes Forms 155 and 998.)

Laboratory, *Purdue.*

Lab. No.	Ship. No.	Piece No.	Stick No.	Mark.	Species.	Kind of test.	Date of test.	Moisture determinations.		
								Wet weight.	Dry weight.	Per cent moisture.
17980	*43*	*16*	*2*		*Hicoria ovata.*	*Bending.*	*3-18-08*	*Culled.*		
81	"	"	*3*		"	"	"	*77.8*	*48.1*	*62.0*
82	"	"	*4*		"	"	"	*78.1*	*50.1*	*55.9*
83	*44*	*1*			*Osage orange.*	*Insulator pins.*	"	*No disc cut.*		
84	"	*2*			"	"	"	"		
85	"	*3*			"	"	"	"		
86	*41*	*13*	*9*	*B*	*Shortleaf pine.*	*Shearing.*	*3-19-08*	*32.7*	*21.4*	*52.7*
87	"	"	*10*	*B*	"	"	"	*33.5*	*23.8*	*40.8*
88	"	"	*11*	*B*	"	"	"	*30.0*	*21.0*	*42.9*
89	"	"	*12*	*B*	"	"	"	*31.3*	*17.5*	*78.9*
90	*35*	*12*			*Loblolly pine.*	*Bending.*	"	*1452.5*	*1193.6*	*21.7*
90	"	"		*(1)*	"	"	"	*81.0*	*69.7*	*16.1*
90	"	"		*(2)*	"	"	"	*145.7*	*120.1*	*21.1*
90	"	"		*(3)*	"	"	"	*295.7*	*244.2*	*20.8*
90	"	"		*(4)*	"	"	"	*214.8*	*180.5*	*19.0*
90	"	"		*(5)*	"	"	"	*113.9*	*95.7*	*18.9*
90	"	"		*(6)*	"	"	"	*107.8*	*86.9*	*24.0*
90	"	"		*(7)*	"	"	"	*219.4*	*177.5*	*23.6*
90	"	"		*(8)*	"	"	"	*198.7*	*160.4*	*23.7*
90	"	"		*(9)*	"	"	"	*241.9*	*194.8*	*24.2*

Form 198. TRANSMISSION CARD. Card No. *25.*

Laboratory *Eugene* Date *Sept. 11, 07.*

I transmit herewith test data as follows:

Form of data.	From Lab. No.	To Lab. No.	No. tests.	Ship. No.	Species.	Moist. cond.	Kind of test.
Log sheets.	*3570*	*3574*	*5*	*2*	*Douglas fir.*	*Green.*	*Bending.*

This concludes bending tests on full size green car-sills. 30 sills were placed outdoors under cover and will probably be ready for testing during July or August, 1908,

Last moisture record sent—Lab. No. *3219.*

(John Doe), In charge.

at which time they are expected to be thoroughly air dried. The Form 1 specimens cut from these last 5 sills are now being tested and sheets will be ready to send to Wash. in a few days.

Date received by Comp. Section *Sept. 17–07.*
Date calculations completed *" 20–07.*
Date summary completed

Form 197 RETURN CARD. Card No. *25.*

Washington, D. C., to *Eugene.* Date *Sept. 20, '07.*

I transmit herewith test data as follows:

Form of data.	From Lab. No.	To Lab. No.	No. tests.	Ship. No.	Species.	Moist. cond.	Kind of test.
Cards.	*3570*	*3574*	*5*	*2*	*Douglas fir.*	*Green.*	*Bending.*

Last moisture record received—Lab. No. *3219.*

John Doe.

DIAGRAMS OF TESTING APPARATUS, ETC.

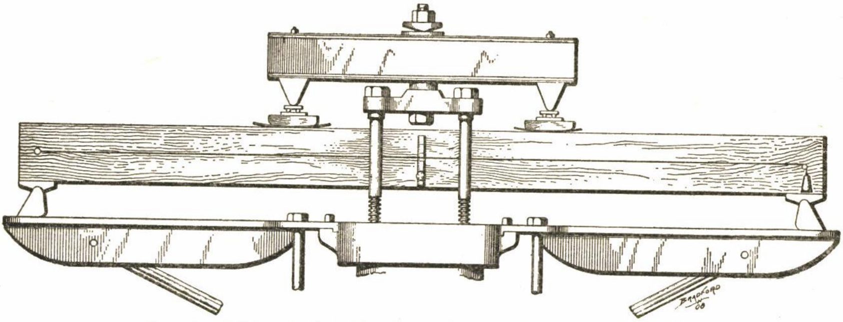

BRADFORD
'08

FIG. 1.—Method of testing large beams under static loading.

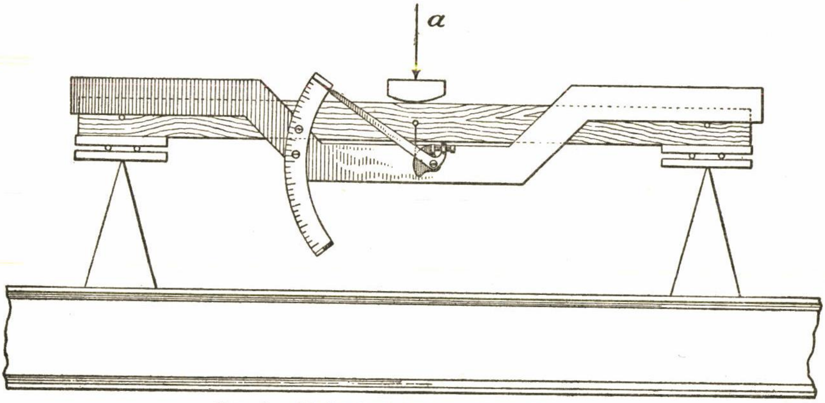


FIG. 2.—Method of testing Form 2 beams.

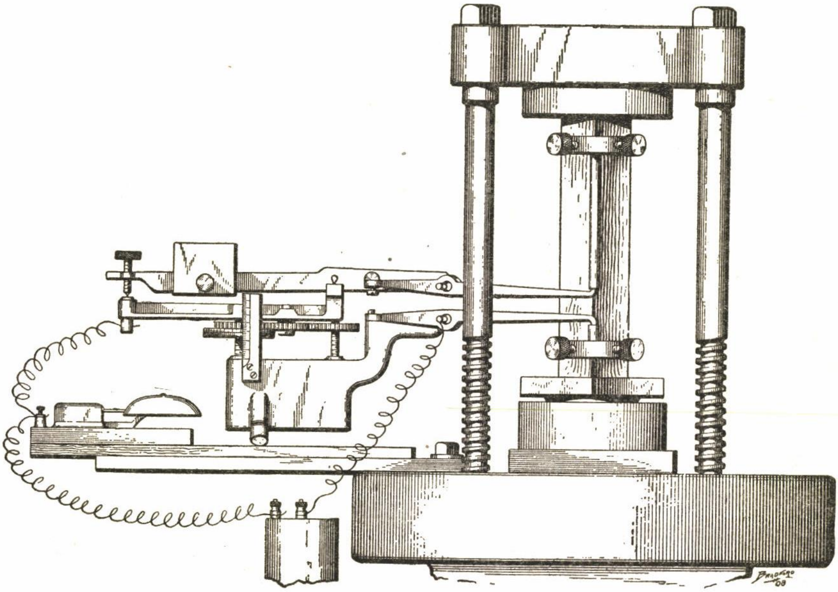

BRADFORD
'08

FIG. 3.—Method of testing in compression parallel to the grain.

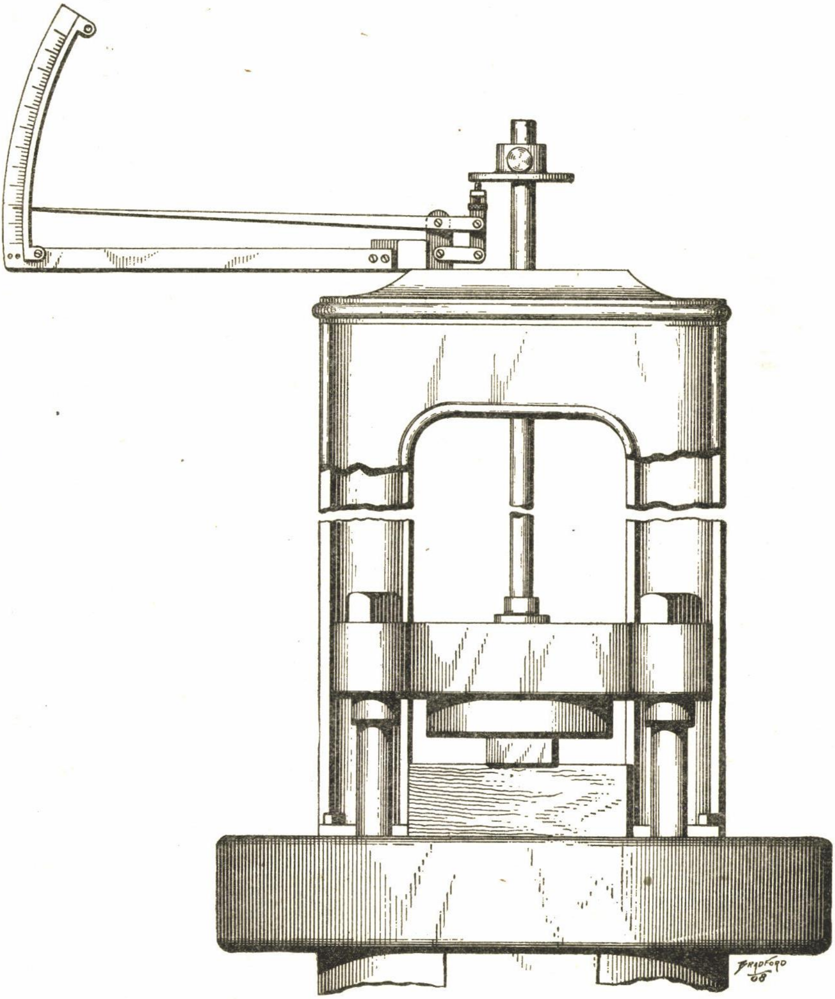

BRADFORD
08

Fig. 4.—Method of testing in compression perpendicular to the grain.

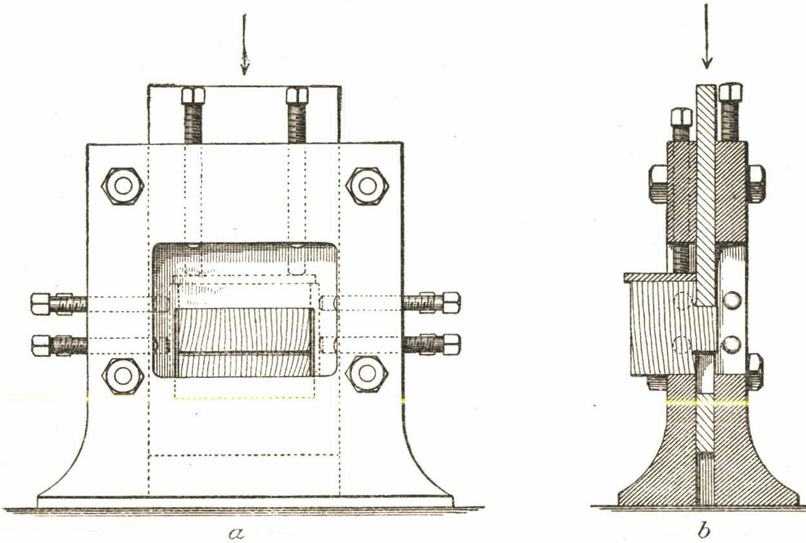


FIG. 5.—Specimens and tool used in shearing tests, both radial and tangential to grain.

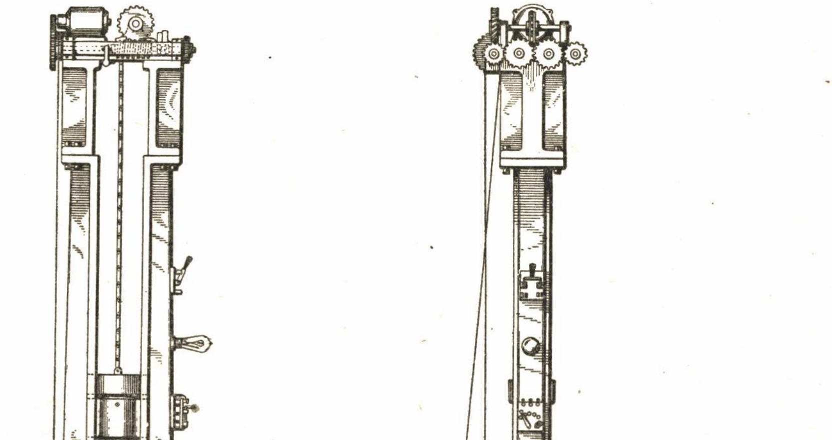


FIG. 6.—Impact machine.

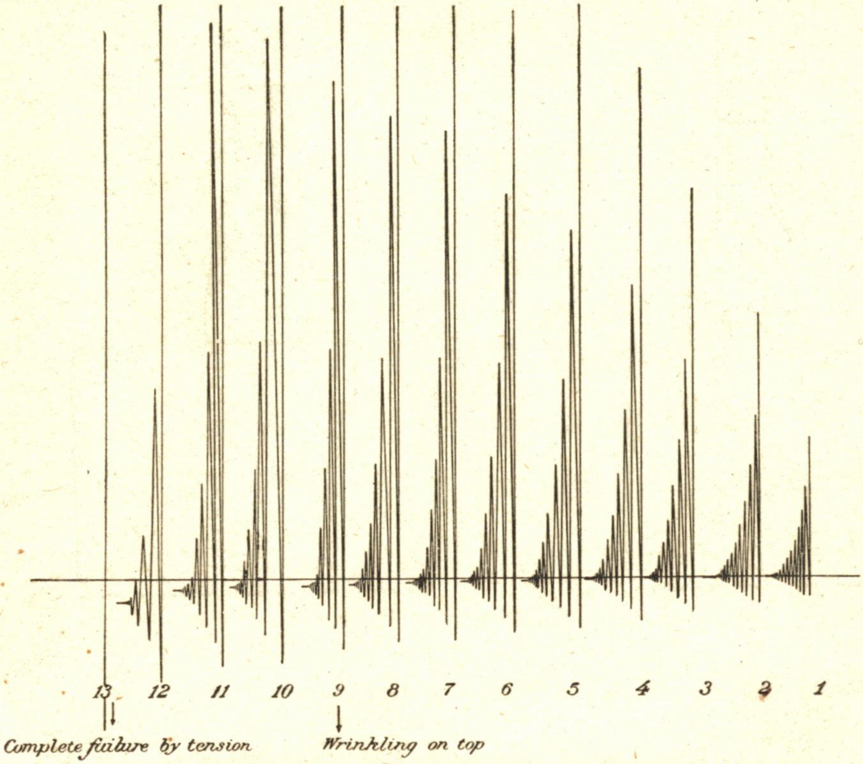


FIG. 7.—Record of impact bending test.

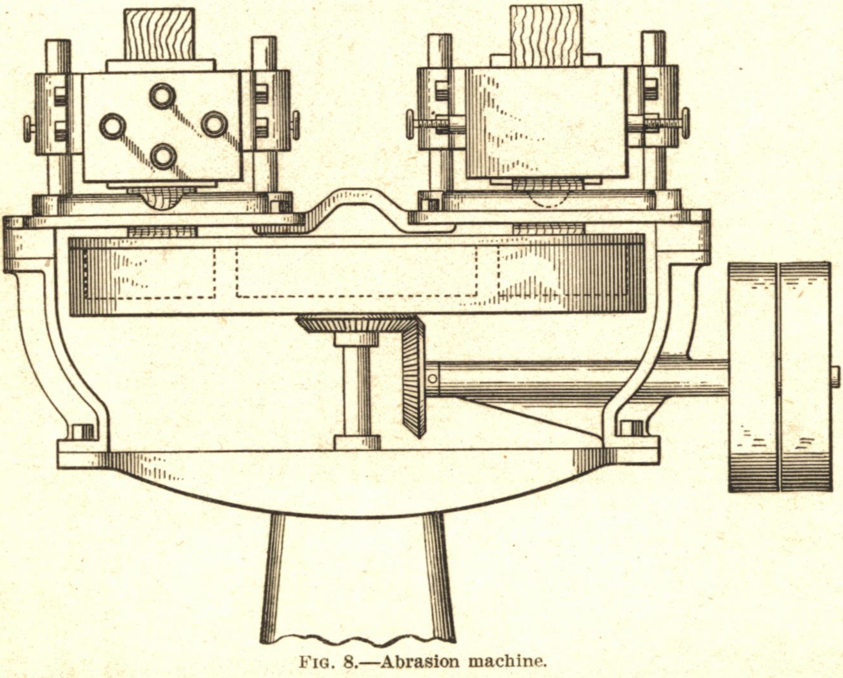


FIG. 8.—Abrasion machine.

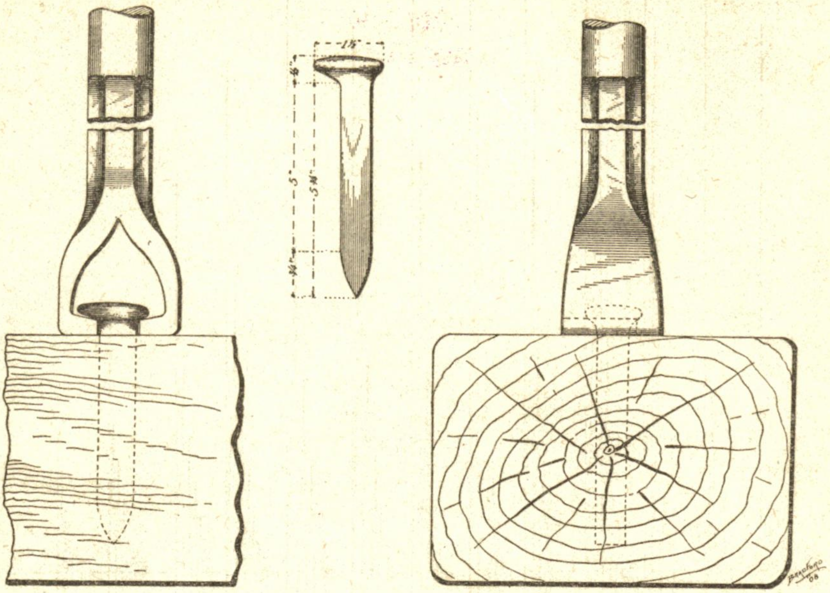

1⅛"
⅝"
5"
5⅝"
¾"
Bradford 08

FIG. 9.—Method of pulling spikes.